The Household Physician

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A Family Guide to the Preservation of Health and to the Domestic Treatment of Ailments and Disease, with Chapters on Food and Drugs and First Aid in Accidents and Injuries

By

J. M'GREGOR-ROBERTSON

M.A., M.B., C.M. (Honours), F.F.P.S.G.

Senior Assistant in the Physiological Department, Glasgow University, and Lecturer on Physiology to Queen Margaret College

With an Introduction by

JOHN G. M'KENDRICK, M.D., LL.D., F.R.S.

Professor of the Institutes of Medicine, Glasgow University

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PREFACE

In writing this book the author has steadily kept before him two main considerations: first and chiefly, he has remembered that the book must be suited for use in the family and household, and that probably it will often be in the hands of those so situated that medical aid will be remote, and perhaps, in many cases, practically unattainable. It is, therefore, written in the simplest possible language, and includes full information on the conditions of health, and on the ordinary means, as regards food, clothing, exercise, &c., by which health may be maintained in the infant as well as in the full-grown person. Diseases to which young and old are liable have been considered more fully than is usual in a popular work; and not only have those simple ailments been explained, which domestic remedies may easily overcome, but also more serious affections, commonly considered beyond the treatment of the unskilled person. Even in the case of diseases so grave that only an experienced and thoroughly skilled man may undertake their treatment with good hope of success, an effort has been made to give such explanations as may enable their serious character to be appreciated in circumstances where qualified help is not attainable; and to make such suggestions of simple means of dealing with them as may have the effect of alleviating the condition of the sufferer.

The second consideration which has guided the preparation of the work is that, more and more, people are becoming desirous of knowing something of the nature and working of the wonderful machine they possess in their body, and that, less and less, are the facts on which the practice of medicine is based being considered a secret science, the knowledge of which is to be held by the few. Information regarding the structure of the human body and all its activities is now eagerly sought after; and it is generally recognized that accurate and trustworthy information of this kind, widely spread, will have a beneficial effect on the public health. Indeed the majority of physicians now prefer to deal with patients to whom they can explain the character of their ailments, in the hope of being intelligently aided in their treatment. Moreover, the author is profoundly convinced that the more fully people appreciate the vast complexity of the human machine and the marvellous fineness of the adjustment of its parts, the more fully they realize the varieties and intricacies of disease, and the difficult character of the problems the physician and surgeon have daily to face, so much the more quickly will the public be delivered from the snares of the uneducated charlatan who trades on the ignorance of his victims, and by so much the more will the truly educated and conscientious physician be held in respect.

The first division of the book treats of the Human Body in Health, and the various changes produced by disease. This part has been divided into sections, each section being devoted to one set of organs. For example the bones and joints are considered in one section, the nervous system in another, the digestive organs in a third, and so on. The first half of each section (A) describes the particular organs in their healthy

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condition, and the second half (B) discusses the diseases to which they are liable. By this method the healthy and diseased states of each part of the body are placed in relationship to and mutually explain one another. Moreover, the various parts of the human body having been considered in proper order, anyone, reading merely for general information and not for any immediate practical purpose, may obtain as full and connected an account of the whole body, and of its working in health, as may be derived from a text-book of physiology.

The second division of the book is devoted to Hygiene, or the conditions of health as regards food, drink, clothing, exercise, &c., and the rules to be observed for the promotion of health, both of individuals and communities. Details are given of the requirements of a healthy house, in its construction, ventilation, water-supply, drainage, &c. In each case the means of discovering anything detrimental to health is explained, and the nature of the remedy pointed out.

In the third portion of the work some space is devoted to explain the nature and mode of action of Drugs and other remedial agents; drugs being here classified according to their varying actions on the human system. But this part includes more than mere drugs. Many of the modern methods of dealing with disease are far removed from the mere administration of a pill or the mixing of a potion. Electricity is daily proving itself to be as valuable an agent in medicine as it is in commerce, and some of the uses now made of it are indicated. Massage, or medical rubbing, another new and formidable antagonist to ill-health, also finds a place.

In the fourth portion of the book methods of dealing with Accidents and Emergencies are noted, and various ailments requiring surgical treatment that could not well be placed in the first division. Finally there will be found a chapter on Sick-nursing, containing a few recipes for Sick-room Cookery, and brief notices of some of the commoner medical and surgical appliances.

For convenience of reference the main technical terms employed have been collected in a Glossary, and their meaning briefly indicated. These explanations are not to be taken as definitions. References have been inserted to the pages where full explanations are to be obtained.

J. M'G.-R.

Preface to the Second Edition.

This work has met with a remarkable degree of acceptance at the hands of the English-speaking people. The author has been gratified by receiving testimony to its usefulness from remote quarters of the Earth; and he has gladly assented to the desire of the publishers to consider whether any changes or additions could usefully be made to assist it still further to meet the wants not only of our people at home, but of the multitudes whom the limitations of our island or other causes annually compel to wander into unfrequented portions of the world.

To simplify and illustrate the text a large number of plates and numerous new woodcuts have been added. In particular there have been added two plates with movable parts to show, in an absolutely clear manner, the situation of the various organs of the chest and abdomen. Very great care has been bestowed on these plates to secure their anatomical accuracy, and they will be found to make a most valuable addition to the work.

The author has also taken the opportunity to revise the text. Several of the sections have been entirely rewritten to keep them in line with recent additions to our scientific knowledge. In proof of this, reference need be made only to the section on the nervous system and to the addition on the bath treatment of chronic diseases of the heart.

These changes and additions have meant to author and publishers the expenditure of much time and trouble, which they hope will be accepted as the evidence of their appreciation of the recognition so widely accorded to the work.

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WEIGHTS AND MEASURES.

The imperial standard is avoirdupois. If a person enters a chemist and druggist's shop to purchase any medicine, the avoirdupois weight is used. But the chemist and druggist is permitted *for dispensing purposes* to use the apothecaries' weight; and *if a prescription is presented,* it is the apothecaries' weight that is employed in weighing the drugs ordered.

Avoirdupois Weight.

16 drachms, or 437½ grains	equal to	1 ounce (*oz.*).
16 ounces, or 7000 grains	„	1 pound (*lb.*).

Troy Weight.

24 grains	equal to	1 pennyweight (*dwt.*).
20 pennyweights, or 480 grains	„	1 ounce (*oz.*).
12 ounces, or 5760 grains	„	1 pound (*lb.*).

Apothecaries' Weight.

20 grains	equal to	1 scruple (*scr.*).
3 scruples	„	1 drachm (*dr.*).
8 drachms, or 480 grains	„	1 ounce (*oz.*).
12 ounces, or 5760 grains	„	1 pound (Troy).

Fluid Measure.

60 minims	equal to	1 drachm (*f. dr.*).
8 drachms	„	1 ounce (*f. oz.*).
20 ounces	„	1 pint.
8 pints	„	1 gallon.

1 minim is equal to 1 drop.

1 drachm, that is, 60 drops or minims, is equal to 1 tea-spoonful.

2 drachms are equal to 2 tea-spoonfuls or to 1 dessert-spoonful.

4 drachms are equal to 2 dessert-spoonfuls or to 1 table-spoonful.

8 drachms are equal to 2 table-spoonfuls or to 1 ounce.

An ordinary sized tea-cup holds 5 ounces.

An ordinary sized tumbler holds 10 ounces, that is, ½ pint.

An ordinary sized wine-glass holds from 2 to 2½ ounces.

Tea-spoonfuls, dessert-spoonfuls, &c., of medicine ought always to be measured in graduated glasses, such as are shown on Plate XIX., opposite p. 1048. Otherwise serious mistakes may occur, owing to the varying sizes of tea and other spoons. Properly graduated spoons are also obtainable.

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GENERAL INTRODUCTION

By

PROFESSOR M'KENDRICK, M.D., LL.D., F.R.S.

IT is the object of this treatise to give such an account of diseases and of their remedies as can be readily understood by persons of ordinary education, and the author has attempted to accomplish this without the sacrifice of scientific accuracy. A simple statement of fact, and a clear exposition of fundamental principles, are perfectly compatible with a scientific treatment of any branch of learning. No doubt, certain sciences require for the statement of details the use of a language to a large extent their own, but the general conclusions even of such sciences can always be expressed in simple and familiar terms. It is a well-known fact that a master in science, he who has a comprehensive grasp both of the facts and of the principles of the science, is more likely to express himself in lucid and intelligible language than the tyro who possesses only a superficial knowledge of his subject. The gift of popular exposition—using the term popular in the best sense—is not necessarily associated with narrow knowledge and shallow thinking, but is often found in the man whose knowledge is wide and varied, and who is thoroughly conversant with the most profound problems of the science he expounds. A perusal of this work will, I believe, justify these statements.

Medicine, in the broad meaning of the term, embraces a wide range of scientific knowledge. It deals with the facts of disease, with the remedies appropriate to various diseases, with the results of accident or injury to the human body, with the causes that affect the origin and spread of diseases, and with the general laws that regulate the health of individuals and the health of communities. Primarily, it may be conveniently divided into external medicine, or surgery, and internal medicine, or medicine proper; that is to say, the diseases affecting the outer frame visible to the eye are relegated to the care of the surgeon, while those that affect the internal organs belong to the province of the physician. Another great department related to these two, is obstetric medicine, or midwifery, dealing with the natural process of child-bearing and with the diseases peculiar to women. Closely connected with this is the department that comprehends the diseases of children. Finally, there are departments dealing with special organs, such as those relating to diseases of the eye, diseases of the ear, diseases of the throat, diseases of the skin, &c. &c., each of which occupies its own domain of knowledge, and is represented by highly-trained specialists

Medicine, however, is not only a department of science comprehending an immense number of facts, nor is it merely a statement of general principles, but it is an art in which practical skill is brought to bear on the detection and the treatment of disease. This is, of course, the aspect of medicine which is of practical importance to the great majority of persons. When a man is suffering from a disease or from the effects of an injury, he desires to be relieved of pain, to have the disease cured, or to have the injury properly treated by the surgeon, and the scientific aspects of medicine or of surgery are of no great importance to the patient; indeed, he may be of opinion that the less he knows of such matters the better. A great deal can be said in justification of this frame of mind, which is not peculiar to the ignorant, but is to be met with also among the learned, and even in members of the medical profession. It is often argued that in the province of medicine, if in any, the trite maxim holds good, that a little knowledge is dangerous, more dangerous some would say than no knowledge at all; that a man can no more be expected to be in any sense his own doctor than he can hope to be successfully his own lawyer; and that the knowledge required by a doctor for the successful exercise of his profession is of such a technical kind that a person of ordinary education can scarcely hope to comprehend it. Surely, it may be said, if the training of a medical man is so elaborate and costly, involving four or five years of study in the class-room, the laboratory, and the hospital, it is not to be expected that outsiders can acquire by a little reading any knowledge of medicine that will be of service to them in daily life. It may be at once conceded that, as regards the more complex diseases, there is some truth in this argument; but, at the same time, when applied to medicine in general, it arises from a partial and imperfect view of the question, and it is an opinion rapidly disappearing before the march of intellectual progress. Medicine is neither more nor less than a branch of natural science. Its facts are of the same nature, and are as easy of comprehension as those of chemistry or physics, or botany or geography. It contains no secrets, no occult mysteries to be divulged only to the initiated; and those who practise it lay no claim to any knowledge but that which may be acquired by observation and patient study. The science of medicine is simply the application of common sense to the explanation of the facts of disease. It is the attempt to see things as they really are, without any glamour of the mystery that is always associated with imperfect knowledge. Such a work as the present, therefore, will not only guide the reader to the diagnosis and the treatment of the simpler forms of disease, and be of great service in circumstances where it is impossible to obtain skilled medical aid, but it will also diffuse intelligent ideas regarding the nature and treatment of the more serious diseases where medical aid is necessary. The physician is not unfrequently thwarted in his efforts, by the ignorance or erroneous views of patients and of their attendants.

Hence an acquisition of the information contained in the following pages, by raising the level of general intelligence, cannot fail in being of the greatest practical service.

Much of the misunderstanding that prevails in the minds of even thoughtful people regarding medicine has arisen from an erroneous view of the nature of disease, and of how much treatment may be expected to accomplish; and not a little quackery, and an inclination to have faith in the nostrums of quacks, can be traced to the same cause. In common with other phenomena, diseases were at first invariably traced to supernatural causes. They were held to be proofs of the direct agency of unseen beings, or of an unseen being. Such a view, of course, associated the treatment of diseases with the special ministers of these unseen powers, and the disease, supposed to be due to the influence of demons or malignant spirits, was exorcised by ceremonies, often of a cruel character, and by prayers and adjurations. In course of time it was gradually recognized that diseases were natural phenomena, but they were then endowed with a personality, and the disease was held to be a principle or entity distinct from its effects. It has required centuries to eradicate this notion from the minds of even the learned, while it still holds its ground, especially among the unlearned, in the thoughts and language of everyday life. Thus the bronchitis, the measles, the cancer, the erysipelas, are still, to many, things, agencies, entities, that have a real existence, abounding here and there, and ready to pounce on the unfortunate being who comes under their malign influence. It followed from this view, that if these diseases are things that somehow get into the body, they must be driven out by strong and urgent measures. The enemy must be compelled to evacuate the citadel of life, even although the citadel itself should be destroyed in the process. Hence the application of violent remedies—bleeding, blistering, purging, &c.—that not unfrequently sapped the very foundations of vitality.

A more rational view now prevails among educated persons, and there can be no doubt that such a treatise as the present will implant and confirm it among those who, by education and habits of thought, are still disposed to entertain the older notions. It is to be regretted, however, that even among intelligent persons the old erroneous views are still to be met with, and nothing is more surprising to a medical man than to find, as he frequently does, a man of strong practical common sense, a man of wide information and shrewd in the ways of the world, a prey to illiterate quacks who impose on his credulity by professing their readiness to give him a specific potion for every ailment and a balm for every sore. Such a man craves for a specific remedy. He has a notion that the disease from which he suffers is a thing for which there must be a specific remedy—not a remedy merely for a symptom, not something that will only relieve pain or promote healing, but something that will actually *cure* the disease. Such views have also led to the

adoption of various systems of treatment. One school holds that only vegetable remedies are appropriate to the treatment of disease, taking a narrow view of the opinions of the old friar who thus soliloquizes:—

> "I must up-fill this osier-cage of ours
> With baleful weeds, and precious-juiced flowers.
> . . . .
> Many for many virtues excellent,
> None but for some, and yet all different.
> O mickle is the powerful grace that lies
> In herbs, plants, stones, and their true qualities:
> . . . .
> Within the infant rind of this small flower
> Poison hath residence, and medicine power;
> For this, being smelt, with that part cheers each part;
> Being tasted, slays all senses with the heart."
>
> —*Romeo and Juliet*, act ii. scene 3.

Another school upholds the virtues of the bath in one or other of its forms, as a universal panacea for all human ills. A third maintains the universal application of the homeopathic principle of "*similia similibus curantur*," "similars are cured by similars"—that is to say, diseases are cured by substances having, in small doses, an action on the body *similar* to that of the disease: so that one may treat diseases by a series of fixed and specific formulæ, all depending on this single principle. Finally, even in orthodox medical circles, there is far too strong a disposition to attribute success in treatment, to the virtues of particular drugs, and some would even assert that ordinary practitioners of medicine, or, as they are sometimes termed, allopaths, simply act on a principle contrary to that of homeopathy, namely, that diseases are cured by contraries, that is, by remedies having an action on the body the *reverse* of that of the disease.

All these extreme and erroneous opinions depend on a mistaken view of the true nature of disease. Disease is the condition parallel to that of health. Now, health is the condition brought about by the natural performance of all the functions of the body, and anything that interferes with the due performance of any one of these functions is a cause of disease. If we represented health by a straight line, disease is a deflexion or bending away of this line. To vary the figure, if we suppose a complicated mechanism like a watch, working efficiently so as to keep accurate time, and with no perceptible disturbance of the play of its various wheels and pinions and chain and spring, we might say that was a condition of perfect health; but if we suppose the watch losing time from too great friction, or from the spring being too weak, or from the teeth of the pinions being worn or broken, then we might call that condition one of disease. This is of course an imperfect analogy, because the human body is infinitely more complicated than a watch; but it is a correct analogy. Anything that interferes with the free and healthy action of

the parts of the body, especially as regards its minute parts—parts to be seen only with the microscope, produces a state of disease, and the symptoms of the disturbance manifest the disease. Thus various diseases are caused by the entrance into the body of living germs which grow and multiply in the blood and tissues, and interfere with the healthy action of the various organs. Such germs, by their presence, cause disturbances that are shown by the symptoms of such diseases as scarlet fever, hooping-cough, erysipelas, &c. Thus there is the high temperature, the congestion and pain in the throat, the eruption on the skin, and such symptoms as headache, sickness, delirium, due to interference with the functions of the nervous system. But the germs are not the disease, but the cause of the disease. By the disease we mean the general phenomena seen in the body and experienced in the sensations of the patient. Again, take any disease of the nervous system. A man is stricken with an apoplexy, and we find he has lost the power of one side of his body. This is not due to something that has entered the body from the outside, but to the breaking down of a certain part of his nervous system. The long strain of years of labour has led to changes in the tissues forming his blood-vessels and his brain, and these changes have been slowly taking place for years before the structure gave way. Thus the disease in this case is due to changes in tissues, and these changes in time cause a part of the bodily mechanism to give way, with the result of the production of the paralysis and of other signs and symptoms. It is clear, therefore, that no specific remedies can be applied to such diseases, and that there is no principle like that of *similia similibus curantur* of universal application.

The true physician has no specific to suggest. His object is to restore as far as possible the conditions of healthy action; to remove, if he can, the causes of the disease; to relieve pain; and to control symptoms so as to direct them toward recovery.

The true physician does not say: "Here is an infallible specific for scarlet fever;" but he moderates the fever by encouraging the action of the skin, he relieves as far as possible the pain and swelling in the throat, he moderates the action of the heart by the skilful use of remedies that restrain the bounding pulse, and he watches for and averts the complications of disorder of the kidneys that may occur, especially during the convalescence of the patient. Again, in the treatment of inflammation of the lungs, he does not profess to have a heroic treatment, such as that of profuse blood-letting, as a sure method of cutting short the disease; but he watches the symptoms, favours expectoration, moderates the pulse, and above all, supports the patient's strength by the skilful use of nutritive fluids or stimulants. Lastly, the surgeon of the present day has no remedy for cancer. He recognizes that its remarkable characteristic is rapidity of growth, so that it invades neighbouring organs, and that it often breaks down the general health by

incessant pain. Hence he advises early removal by the knife, the relief of suffering by the careful use of anodynes, and the support of the general health by nutritive and easily-digested food. These illustrations show the present stand-point of a rational physician or surgeon, and they are to be commended to the attention of intelligent members of the general public.

The method of this book illustrates the rational view of disease and of treatment that I have endeavoured to explain. If disease is merely a disturbance of the natural functions of the body, it follows that an intelligent knowledge of these functions must first be attained. This leads to a discussion of the structure of the body and of the functions of its various tissues and organs, or, in other words, there must be a basis of anatomical and physiological knowledge. Next comes the pathology, as it is termed, of the disease, that is to say, the nature of diseased processes as distinguished from those occurring in health, and here the author, in many places, illustrates the well-known fact that many diseased processes are only modifications of natural processes. Many diseases are abnormal examples of healthy processes, processes occurring at the wrong time, in the wrong place, or to too great or too little an extent. After a careful description of the general symptoms of the disease by which it may be detected and discriminated from other diseases, the nature of remedies must next be discussed. The author here applies the important principle that the physiological action of drugs is the guide to their action in disease, that is to say, we must first determine what is the action of the drug in health, upon the heart, circulation, respiration, brain, &c., before we can rationally employ it in the treatment of disease. At the same time, it must not be forgotten that it is just this department of medicine which is wanting in precision and which requires much extension. Many remedies are still employed because they have been found by experience to be useful, without any theory as to their mode of action. The author has made skilful use of such remedies, indicating the empirical facts that show their value.

There is no doubt a large amount of scepticism regarding the value of medicines, more especially in the medical profession itself. This arises from the difficulty often experienced of ascertaining with accuracy whether or not the apparent cure has been the result of the action of a particular drug. Many elements may contribute to a patient's recovery in addition to the special action of the medicines given by the physician. Diet, rest, careful nursing, cleanliness, the natural constitution of the patient, and his mental condition all exert an influence, and the recovery is the outcome of a number of conditions. With this knowledge, an honest physician often hesitates in giving the credit to the drugs employed. At the same time, experience has abundantly shown that drugs, judiciously used, are often of great value, and at all events materially contribute to the causes of recovery; and we may reasonably expect that as knowledge of their action on the

body in health and in disease advances, the physician will be furnished with more and more trustworthy substances by which he can aid in the recovery of his patient. These views also point to the immense importance of regimen and diet in the treatment of disease.

The author has treated very fully the general conditions of personal and public hygiene, and he has discussed in the light of modern researches the influence of minute living organisms in the production of disease. Probably there is no chapter in modern medicine of greater importance than this, in which many diseases have been traced to the action of minute germs, microscopic organisms, which, finding their way into the blood and tissues, set up changes therein that are often incompatible with life. The life history of such organisms in connection with the phenomena of fermentation and putrefaction has in recent years been carefully investigated, and the author has skilfully placed the results before his readers. It is not too much to say that whilst we may be alarmed by the thought that many virulent diseases are thus caused by invisible foes, the outlook is very hopeful, because a knowledge of the habits, mode of development, and general life history of these minute organisms will guide the sanitary physician towards the adoption of measures by which outbreaks of such diseases may become almost impossible.

The author explains, in a separate introduction, how the stores of information in this book may be made practically available. My belief is, that while it inculcates the employment in all serious cases of medical assistance when that can be procured, and while it lends no countenance to anyone arrogating to himself the duties of the skilful physician or surgeon, it presents a fair and intelligible view of medical science, and cannot fail in diffusing valuable information regarding one of the most important departments of knowledge. A careful perusal of these pages will not puff up anyone with vain conceit, but will rather lead him to clothe himself with the garb of humility and to maintain an attitude of reverence in the presence of the vast body of knowledge laid before him. All that extensive knowledge and a singular faculty of lucid description can do to make the work interesting and instructive has been accomplished by its author.

JOHN G. M'KENDRICK.

The Household Physician

PART I.

THE HUMAN BODY: ITS VARIOUS TISSUES AND ORGANS, CONSIDERED AS TO THEIR STRUCTURE AND FUNCTIONS, (1.) IN THE STATE OF HEALTH AND (2.) AS ALTERED BY DISEASE.

INTRODUCTION.

Health: Its *Conditions.*

Disease: Its *Kinds*—Organic and Functional; Congenital; General or Constitutional and Local; Zymotic—Epidemic, Endemic, Sporadic—Hereditary and Acquired; Acute, Subacute, and Chronic.

Its *Causes*—Predisposing: Age; Sex; Surroundings; Occupation and Habits; Heredity; Previous Disease—Exciting: Mechanical; Chemical; Vital.

Its *Detection*—Subjective and Objective Symptoms; General and Special Examination of the Body; Diagnosis and Prognosis.

Its *Treatment*—General and Special; Preventive, Palliative, Specific, and Expectant.

THE human body in health may very well be compared to a steam-engine in thorough working order. Such an engine is made up of a great many different parts, each of them of good material, well made, and each part accurately fitted into its proper place. The furnace is supplied with its due quantity of coal, the boiler with its due quantity of water; and steam is produced in proper quantity to drive the engine. Now the result of the orderly and harmonious action of all the parts is that, as soon as the motive power is applied, the engine is propelled along the road, regularly, and smoothly, and speedily. It is not sufficient, however, that the engine should start in good order, it must be *maintained in good order*. This is the work of the engineer, whose business it is not only to drive the engine, but also to take care that nothing is permitted to interfere with it, that the boiler is kept clean and duly replenished with water, that the smoke has free vent, and that the ashes, or whatever would choke the furnace, are regularly got rid of, and in every other way to keep it bright and clean. This is a picture of the human body in health. It, too, is a machine made up of many different parts or organs, as they are here called, bones and muscles, heart and lungs, liver and stomach, brain and nerves, and so on. These parts must be well made; there must be no flaw or defect in their structure. It, too, has its driving force, or motive power, obtained from the food which has been digested by the stomach and bowels and passed into the blood. Here also each organ, or part of the body, ought to work in union and harmony with every other part. The human machine likewise produces its waste materials, and these, like the smoke and ashes of the steam-engine, must be regularly got rid of. Thus the comparison of the living human body to the working steam-engine enables us to see that for health there are, generally speaking, three things necessary, viz.:

I. The different parts of the body must be without defect, each organ must have its structure perfect; and the different organs must work harmoniously together.

II. The motive power must be regularly maintained; that is, the body must be properly nourished.

III. All waste materials produced by the work of the body must be regularly expelled from it, else they will collect in the blood and so interfere with the healthy condition of the body.

Now let us see more exactly what these conditions of health mean.

I. While perfect structure of every part is the first condition of health, there are certain imperfections that may exist, and yet it is not possible to say that disease is present. Thus a man may have lost a limb or an eye, or be deaf on one side, and yet be perfectly healthy. Or

he may, at one time, have had disease of the lungs which has been cured, but has left in the lung some change in its structure, yet he may be quite healthy; and so of other organs.

II. The second condition includes a great deal more than, at first sight, is apparent. It means, first of all, that the person must have a proper quantity of food, and food of the right sort. The food must be acted on in a certain way by the stomach, bowels, liver, and other digestive organs, so that the nourishing portion is separated from it and is prepared for admission into the blood. So prepared it must gain entrance into the blood and form part of it. The blood is thus a nourishing fluid, which must be distributed through every part of the body, each part getting a sufficient amount of it. For this purpose a series of vessels is necessary to act as channels along which this fluid nourishment is to be driven, and there must be some kind of apparatus to drive it along to the remotest parts of the body. This duty is performed by the blood-vessels and heart, the heart acting as the force-pump in the circulation of the fluid. Finally, the blood being sent through the whole body, each organ, and each little particle forming the organ, must be able, when the blood is brought to it, to select from it what it needs for its continued life, and growth, and action. So that the blood is a nourishing stream flowing through every portion of the body, and so thoroughly distributed that not the smallest particle of which the body is composed can fail to get its share, or fail to find what it requires. Under this second condition, therefore, is included **food, digestion,** the process of **blood making,** the **circulation of the blood** by the heart and blood-vessels, and **nutrition proper,** or the nourishment of the particles of which the various organs are composed.

III. But the blood is more than a nourishing stream. When a muscle works—when it contracts—it uses up a certain amount of its substance, and other substances are produced which would do harm if allowed to remain in the muscle—waste products. These waste products are continually being produced by every action of the body—the beating of the heart, the movements of breathing, the activity of the brain; and so the waste materials of the whole body are of considerable amount. These are all poured into the blood, and it becomes therefore a drainage system also. By this means it is made impure, and if circulated in this state becomes unfit for nourishment. It must, therefore, be purified. There are, accordingly, a set of organs set apart for the purpose of continually removing these waste materials and casting them out of the body. Thus the lungs remove from the blood and expel one waste substance in particular—carbonic acid gas, the kidneys remove others, and the skin takes its share in purifying. This is called a process of **excretion,** or removing from the blood substances which are afterwards to be cast out of the body. Besides this, certain parts of the food, which after digestion remain as unnecessary for the blood or of no value for it, must also be expelled, and are passed out from the bowels. This third condition, then, includes **respiration, excretion** by the lungs, kidneys, skin, bowels, &c.

The conditions of health thus imply good **structure of the body, proper food, digestion, blood making, blood circulation, nourishment of the tissues** of the body, and **purification of the blood** by the means last mentioned. All these different processes ought also to be properly regulated and controlled, and this duty is performed by the nervous system. While over and above all there is the man himself, who ought to be to his own body what the engineer is to his engine, who, if he has a perfect machine in his possession, may keep it so with attention and care, but who may spoil the best possible by mismanagement, carelessness, or abuse.

To complete the comparison between the steam-engine and the body, it has been noticed that the engine in thorough order works smoothly. It seems to the engineer to glide along; he is hardly aware of its movement, so perfect is its working. So it is with the human body in health. The man hardly knows his heart is beating; he breathes without effort. So perfect is his digestion he hardly knows he has a stomach. All the needful activities of the body go on without his interference, almost without his knowledge; in fact, he is almost unconscious of their existence. But as soon as something is wrong, then, as a rule, he becomes somehow aware of it; the beating of his heart oppresses him; pain tells him where his stomach lies; his brain seems on fire. In some way he becomes conscious of the actions within him.

Health then consists in the perfection of the different organs of the body, and in their regular, harmonious, and unconscious working.

If we remember these conditions of health it will be seen how easily and in how many ways disease may arise. Look at the second condition, that referring to the proper nourishment of the body, and notice how that condition is violated if bad food be given, or good food, but

too much or too little of it. Or suppose the food to be sufficient and good, if it does not get the chance of being properly digested, or, if digested, is not taken up into the blood, the nourishment is at once interfered with. Suppose again some obstacle to the flow of blood through the body, suppose the heart not working vigorously enough to drive the blood to the uttermost parts of the body, in all these and similar ways disease may at once arise. Again, take the third condition of health—the removal of waste materials. If the lungs are not performing their office the blood at once becomes impure by the accumulation in it of hurtful gas, carbonic acid, and the want in it of the gas it needs, oxygen. If the kidneys do not work properly other impurities are allowed to remain. The blood thus becomes an impure stream poisoning, instead of nourishing, the body through which it flows. In all these ways, then, the conditions of health may be violated and disease set up.

THE KINDS OF DISEASE.

It is not, then, difficult to understand what is a state of disease. Suppose that instead of perfect there is imperfect structure, an organ or series of organs whose structure has by some means become changed, or has been from birth defective, there you have obviously disease. This disease need not always be apparent. For instance, take the case of an engine, the inside of whose boiler has become in some parts eaten into by rust. The parts will be thinner than should be, and will be therefore weaker than other parts not affected by rust. They will, therefore, be unable to bear the same strain as the whole plates of the boiler. Yet the engine may be working quite well, and no one be aware of the flaw. But suddenly let the steam gain a pressure greater than the thinned plate can stand, without warning it bursts, and the defect is suddenly and terribly revealed. Similarly a man may go about in apparently perfect health, yet a flaw may exist in the structure of some of his organs which is unknown until the occurrence of a strain greater than the affected organs can resist. Take a not uncommon case: the blood-vessels of a person have, through age or other causes, become weak and inelastic. The man one day becomes excited, his blood rushes with unusual force through the body, driven by the excited heart, some small vessel in the brain, unable to withstand the increased pressure, gives way, and the man drops down unconscious, and soon dies. Thus, then, there is a class of disease due to defective structure of the organ or organs, and these are called **organic diseases.** This change or defect in the structure in most cases occurs in the course of the person's ordinary life, but sometimes the person is born with the defect. Thus a child may be born with the heart imperfect, so that one side communicates with the other (see DISEASES OF CHILDREN), or with eyes the lenses of which, instead of being clear and transparent, are opaque, so that the child is blind. (See DISEASES OF CHILDREN—*Cataract.*) Such structural diseases, born with the child, are called **congenital.** But, again, it is possible to have an engine, every part of which is properly made and properly fitted, and yet the engine does not work well or smoothly. The engineer finds nothing amiss, but he loosens a screw here, tightens another there, or oils some parts, and away the engine goes in perfect order. Similarly a man's body may, to all intents and purposes, be perfect as regards structure, that is, he has no organic disease, and yet he is not in good health. His heart may be quite perfect as regards structure, and yet it alarms him. He is troubled with palpitation or some other irregularity of its beating. In other words, an organ may be without defect in its make, but it may not work very well, it may not perform its duty properly. Now the duty an organ has to discharge, the work it has to perform, is called its **function.** Therefore a distinction is drawn between the class of diseases due to defects of structure, **organic or structural diseases,** and the class of diseases due to organs perfect in structure, but not performing their functions properly; and this latter kind is called **functional diseases.**

Besides this division into organic and functional, diseases are spoken of as being **general** or **constitutional** and **local.** A **local** disease is one which is confined to a particular part, and does not affect the rest of the body. Inflammation of the knee-joint, for instance, to which house-maids are liable, is a local disease. A **general disease,** on the other hand, affects all the body, such as scarlet fever, measles, diphtheria, &c. **Constitutional,** perhaps, means rather more than general. It means very often not only that the disease affects the nourishment of the whole body, but also that it is due to, or attended by, some peculiar condition of the body. For example, consumption, scrofula, cancer, are types of constitutional disease. These diseases do not merely make themselves felt by the whole body, but they impress on it a peculiar character.

There is a large class of diseases called **zymotic**, from a Greek word *zymosis*, meaning fermentation. These diseases are so called because it is believed they are due to certain poisons which get into the blood in minute particles or germs, and there increase and multiply, the disease lasting until the poison has become worked out, or has been destroyed. Small-pox, measles, scarlet fever, diphtheria, influenza, &c., are instances. These zymotic diseases may be **endemic or epidemic. Endemic** means that they are peculiar to certain localities or situations, such as goitre or Derbyshire neck, common in certain Midland counties of England and in parts of Switzerland. Endemic diseases are generally due to some special causes connected with the district which they affect—its atmosphere, water supply, drainage—and they tend to remain. An **epidemic disease** is one which suddenly comes among people and spreads through them rapidly far and wide, lasting for a time, and then dying away. Influenza, and scarlet fever, are instances. **Sporadic** is applied to such diseases when they are not endemic or epidemic, but occur, one here and another there, in scattered places with no apparent connection one with the other. See FEVERS.

Then there are diseases **hereditary,** which have descended from the parents, and diseases **acquired,** which the person was quite free from when born, but was attacked by at some later time. It must be observed, however, that the same disease may have been hereditary in one man and acquired by another. Take consumption: one man had a consumptive father or mother, he was born with the seeds of it in him, and in due time those seeds developed into the full-blown disease. Another man was born quite healthy, but he caught cold; it settled down in his chest, as the saying is, and affected his lungs, which in course of time became consumptive.

Disease may be **acute, subacute, or chronic.** When it is **acute** it has a sudden onset, is severe, runs a certain course, and ends, generally, within a certain time. When it is **chronic** it has no such definite onset, course, or duration, and is not so severe. Its course is slow, it lasts longer, and may, indeed, never be finally got rid of by the sufferer. The **subacute** occupy a position between these two both in severity and length of time. These forms may, of course, pass into one another, the acute becoming chronic, or the chronic suddenly taking on the characters of an acute attack. In connection with chronic diseases there is employed a word **cachexia.** It means a bad habit of body, a bad condition which has become impressed on the body. It is, therefore, the result of disease, a permanent state which disease has produced. Thus the *scrofulous cachexia* is spoken of, the condition of body due to scrofula, shown by slender form, narrow or deformed chest, pallor, diseased glands, large prominent joints, &c. There is also the *cancerous cachexia,* attended by pale sallow complexion, a desponding expression of countenance, extreme thinness, &c. A person is said to be **cachectic** when he or she bears about such evidences of a chronic disease.

THE CAUSES OF DISEASE

(ÆTIOLOGY OF DISEASE).

The causes of disease are usually divided into two great classes, **predisposing and exciting causes,** which we shall consider in detail.

A. PREDISPOSING CAUSES OF DISEASE.

Predisposing causes are those which so affect the bodily condition of a person as to render him liable to disease—such causes as so reduce the resisting power of the individual that, when attacked by the disease, he is unable to drive it off, and it takes possession of him. Now there may be causes rendering a person disposed or subject to disease in general, or there may be peculiarities about a person which render him liable to one disease in particular. Thus a man who is overworked or underfed is a ready victim for any disease which may come his way; he is like soil fit to grow any seed that may fall upon it; the man who comes of a consumptive family is specially open to affections of the lungs; and so on. The chief predisposing causes are the following, viz.:

1. **Age.**—Youth and old age are particularly susceptible of disease for easily understood reasons. The child is in a state of active growth and development, when the various organs are not fully grown nor their duties fully undertaken, and when the whole system is in a condition of great activity, and therefore easily disturbed. Thus the digestive organs may be easily disordered. The relation between the different parts of the nervous system of the child is not fully established, the spinal cord is highly sensitive, and so convulsions and other nervous disorders are frequent. Teething brings a multitude of attendant troubles. St. Vitus' dance, acute rheumatism, asthma, scrofulous disease, worms, are common among children, while they have great difficulty in avoiding in-

fectious disease like scarlet fever, &c. A later period of youth, again, when the sexual powers are being formed, is a time of increased activity, and therefore of increased liability. On the other hand, old age is a period of decline, when all the powers are on the wane, when the ability to fight against attacks of disease is greatly lessened. This, therefore, is the chosen time for diseases of decay and degeneration, when the heart tends to become weak and fatty, the blood-vessels hard and brittle instead of elastic, and the brain soft, the time of paralysis and frailty of all kinds. As the reverse of this the period of maturity, when development has been completed, is the time of greatest power of resisting disease, just because all the bodily forces are in full operation.

2. **Sex.**—Women of course are liable to certain diseases from which men are, of necessity, free. Others very common to women attack men only very rarely, such as hysteria and forms of bloodlessness (anæmia and chlorosis).

3. **Surroundings.**—This includes the influence of air, heat, cold, moisture, of climate, &c. Some diseases are specially prevalent in the cold months, others in the warm months of the year. For instance, the effect of cold in producing bronchitis, of wet in producing rheumatism, of heat in producing sunstroke, is an illustration of this. Then the association between marshy undrained districts and ague is well known. Diarrhœa and dysentery, and affections of the liver, are common in tropical countries. Again, every one knows that patients with a consumptive tendency seem specially benefited by residence on high levels and among dry, clear air. But even apart from differences of district or climate, the effect on health of surroundings more directly under the control of individuals themselves ought to be specially noticed. The difference between the health and robustness of those who live in the town and those who live in the country is practically a difference of atmosphere. Similarly those who live in large, well-ventilated, roomy houses are in a much better position for fighting ill health than those who spend their days in ill-ventilated or overcrowded apartments. Just for the same reason the part of a town where the streets are wide, and where there are parks or other open ground, has a better chance of escaping a visitation of disease than a part crowded with high closely-built houses separated by narrow lanes, and with no breathing spaces.

4. **Occupation and Habits.**—The two great kinds of occupation are the *sedentary* and the *active.* It is easily seen how the man whose business gives him physical exercise has an advantage, from the health point of view, over the man whose work keeps him closely confined to a study or desk. The man of sedentary occupation, and those who work with their brains rather than with their hands, are frequent sufferers from indigestion, constipation, and the like. As regards special occupations, many of them have special diseases, such as *writer's cramp, wrist-drop of workers in lead,* particular kinds of *lung disease* and *disorders of the eye* in *miners,* and so on. As to habits, over-feeding has its tendency to disease as over-drinking has; luxury weakens rather than strengthens. Irregular habits of all sorts tend as much to encourage and invite disease as regularity is one of the strongest defences against it.

5. **Hereditary Influences.**—This signifies the influence exerted on a man by his parents and grandparents, for the influence may extend backwards through several generations. It affects his bodily structure and mental powers; and his personal peculiarities are often due to its effects. So that the influence of heredity on the liability of a man to disease, or to a particular disease, is very great and important. A remarkable instance, illustrating the transmission of a peculiarity of structure, may be given. A Maltese named Gratio Kelleia had six fingers upon each hand and six toes upon each foot. He married a lady having the usual number of fingers and toes; and they had four children. "The first child, a son, Salvator, had six fingers and six toes like his father; the second, George, had five fingers and toes, but one was deformed; the third, André, had five fingers and toes, perfect; and the fourth, a girl, Marie, had five fingers and five toes, but her thumbs were deformed. These all grew up and married five-fingered and five-toed individuals." . . . "Salvator had four children; they were two boys, a girl, and another boy; the first two boys and the girl were six-fingered and six-toed like their grandfather; the fourth boy had only five fingers and five toes. George had only four children; there were two girls with six fingers and six toes; there was one girl with six fingers and five toes on the right side, and five fingers and five toes on the left side, so that she was half and half. The last, a boy, had five fingers and five toes." The third, André, who was perfectly well formed, had many children, whose hands and feet were regular. "Marie, the last, who, of course, married a man who had only five fingers, had four children; the first, a boy, was born with six toes, but the other three were

normal." Now it is to be noticed that if peculiar external form can be inherited, so also can internal form and structure. We know that the structure and development of an organ have great influence in determining health or disease, so that a man may inherit some peculiar form, say of heart, or brain, or liver, or some peculiarity in arrangement or relative size of blood-vessels, that may render him liable to particular kinds of disease.

It is well known how children resemble their parents in appearance, mental qualities, and peculiarities of disposition and character. It is supposed that the influence of the father is specially seen in the general form of head and limbs, while the influence of the mother is more internal, and affecting the way in which the vital functions are performed. It is also important to notice that peculiarities of the father will more surely affect the sons, and those of the mother will rather influence the daughters; and the father will less frequently transmit peculiarities to the daughter, and the mother to the sons. This is a rule, however, to which too much consequence must not be attached.

It is not only possible for a man to inherit from his parents a peculiarity which he transmits to his children, but he may himself acquire, by habit or otherwise, an entirely new peculiarity which he may hand down to his posterity, for habit has great power in producing peculiarities of constitution. Thus in two ways a man may affect his children: (1) by handing down to them something *he has inherited*, and (2) by handing down something *he has himself acquired.*

A very important question here arises, viz., "Is it possible for a man to influence in any way some such inheritance?" Suppose a man has inherited from his parent a peculiarity of temper or disposition which is inconvenient or bad, can he do nothing to prevent this being passed down to his children in full force? Laying aside peculiarities of form, it can be proved that an inherited habit or peculiarity can be strengthened and confirmed, and the probability of its being transmitted thereby greatly increased, by regular use, while it may be weakened by disuse, and the chance of it appearing in the children thereby diminished. So that a particular tendency may become quite confirmed in a family and characteristic of it by cultivation, while the same tendency may be caused to disappear by neglect.

The practical bearing of all this is more important in relation to health and disease. Many diseases are capable of transmission, principally consumption, scrofula, gout, syphilis, and insanity. As in the case mentioned above, malformations may be inherited. Besides these certain nervous affections seem to run in families, such as asthma, neuralgia, and other diseases, for example, cancer, forms of skin disease, and fatty changes. Heart-disease, rheumatism, and St. Vitus' dance are interchangeable, that is, rheumatism in the parent may transmit heart-disease or St. Vitus' dance to the child. Similarly epilepsy or falling sickness, St. Vitus' dance, hysteria, and habitual drunkenness seem interchangeable; for instance, habitual drunkenness in the father may produce one of the other affections in the child.

To apply to disease what has been already noted:

(1.) A parent may transmit to his child either an *actual disease* or a *tendency* to it which he himself inherited from his parent.

(2.) A parent who has inherited a tendency to, say, insanity or drunkenness may, by unceasing care and precautions on his part, diminish the tendency in himself and lessen the risk to his children. The reverse is equally true, that a parent who, by his habits and mode of life, rather encourages the tendency and develops it, may transmit the tendency in greater force or a worse form to his children. It is of so far-reaching importance that as many people as possible should, for their own and the sake of society, be made aware of these things, that the following striking example of the course of hereditary disease unchecked in four generations is given:—

First generation: Immorality, depravity, alcoholic excess, and moral degradation in the great-grandfather, who was killed in a tavern brawl.

Second generation: Hereditary drunkenness, attacks of mania, ending in general paralysis in the grandfather.

Third generation: Sobriety, but tendencies to delusions, delusions of persecutions, &c., and tendencies to homicide in the father.

Fourth generation: Defective intelligence, first attack of mania at sixteen, stupidity ending in complete idiocy. Furthermore probable extinction of the family.

Now it is almost certain that this progress in degeneration, by cultivating the hereditary tendencies, might have been made a progress in the reverse direction by a continued effort to overcome and destroy the tendencies. The same may be true of a disease like consumption, so notoriously hereditary. It might be quite possible for a parent, who had a marked family tendency to

consumption, by careful living, to keep it in abeyance; and his success would doubtless influence his offspring. If they, in their turn, were similarly careful a still diminished liability might be transmitted by them. By such a process as this, repeated through several generations, the disease, which at first threatened extinction of the family, might finally be rooted out.

(3.) A parent who may have inherited a robust enough constitution may himself acquire a disease, syphilis, for example, which he then hands down to his child; or by drunkenness or other excesses he may transmit a constitution, if not actually diseased, at least very prone to disease. For instance, it has been found possible to produce epilepsy in guinea-pigs by dividing a certain nerve; and these guinea-pigs, affected by a disease artificially produced, have afterwards given birth to young which were subject to convulsive attacks. So it is that a man by alcoholic excess may be the cause of insanity, idiocy, weak-mindedness, or a tendency to these, in his offspring.

A singular thing in reference to inheritance is, that a peculiarity of structure or character may skip one or more generations, and reappear in other succeeding generations. The father may have it, his children escape, but his grandchildren manifest the same tendency. This is called **atavism**, which simply means a return to the state of the grandfather.

Darwin has pointed out a rule, which he says may be trusted, that "at whatever period of life a peculiarity first appears, it tends to reappear in the offspring at a corresponding age, though sometimes earlier." To some extent this is true of hereditary disease, and might, if widely known, be taken advantage of, so that steps might be taken, before the arrival of the particular age, to avert, if possible, the development of the suspected disease.

It may be well to note a very curious fact, that a mother, who has previously borne offspring, may afterwards have children, by a different husband, *bearing the characteristics of the first.* Thus a widow who marries a second time may, by the second husband, have children strongly resembling the first.

Finally there are other peculiarities which not infrequently "run in families," such as, the disposition to be more strongly or disagreeably affected than usual by certain drugs, like mercury or opium, or less strongly than usual, the tendency to be influenced by the smell of fresh hay or the perfumes of certain flowers, the inability to take, without discomfort, certain kinds of food, such as mutton, or even simple medicines like magnesia, and the tendency to catch any and every disease that may be "going," or great freedom from and indisposition to disease.

Thus, in estimating causes of disease, hereditary influences in their direct bearing, and in their bearing on personal peculiarities, must not be overlooked.

6. **Previous disease** is another great predisposing cause of disease. Of course previous disease may act as a safeguard against the return of the same disease, thus small-pox and some similar affections give immunity from a second attack. On the other hand it is the rule, in very many cases, that once having the disease means always liable to it. Thus it is always the case that a person who has had an attack of quinsy, an inflammation of the tonsils, cannot be exposed for any time to cold or wet without great risk of its return. Erysipelas, boils, the kind of cold commonly called influenza, bronchitis, inflammation of the kidneys, are very troublesome in this way. Further, one disease often produces a liability to another and quite different malady. One of the most common examples is acute rheumatism, the great danger of which is that it may lead to heart-disease, while it may also cause liability to St. Vitus' dance. Again, many kinds of skin disease, bone diseases, throat affections, nervous complaints, diseases of the eye, ear, nose, &c., paralysis, epilepsy, and in fact almost any kind of disease, may be due to syphilis, contracted many years before, and may with difficulty be traced back to their true origin.

In concluding this review of predisposing causes of disease it should be stated generally that the great predisposing cause is, putting it popularly, "*letting one's system get down.*" Let a man tax his energies with overwork, let him get depressed in spirits by worry or anxiety, let him, for any time, neglect taking regular and proper diet in sufficient quantity, his natural vigour becomes, perhaps not apparently, but gradually diminished, and he loses some of his power of resisting disease, and so is liable to fall an easy prey to some affection which, in his robust condition, passed him by.

In connection with these predisposing causes of disease a word is frequently used which it may be well here to explain. A person may, owing to previous disease or owing to inherited peculiarity, have a strong tendency to a particular affection, in which case he is said to have a particular "**diathesis,**" which simply means

tendency. Thus an individual who came of a consumptive stock, might be said to have the *consumptive diathesis;* so a man might be of the *rheumatic or gouty diathesis.* He need not have had the disease, but simply is strongly inclined that way. The possession by a person of a particular diathesis should never be overlooked.

B. EXCITING CAUSES OF DISEASE.

These include the causes which immediately and directly produce the disease and give to it its character. Thus, in the case of an old woman whose arm is broken by a not very severe blow from a stick, the predisposing cause is old age, which has rendered the woman's bones brittle, and the exciting cause is the stick.

There is a variety of exciting causes.

1. **Mechanical Causes.**—Violence of any kind applied to the body belongs to this class. Mechanical exciting causes may also attack the body *from within.* Thus a gall-stone, which blocks the tube leading from the liver, will cause severe pain, jaundice, and so on, simply from its mechanical obstruction. Stone in the bladder is another example. Again, stoppage of the bowels may be due to mechanical causes, the blocking of the passage by masses of hardened excrement, or by twisting or narrowing of the bowel. The windpipe may be closed by something that has accidentally slipped in from the mouth, &c.

2. **Chemical Causes.**—These include poisons of all kinds introduced into the body from without. They also embrace the action of substances which may have originated in the body itself, such as waste products, and which the body has failed to expel. Thus the kidneys may fail to expel certain waste materials, and convulsions, or dropsy, result; the liver may be the organ at fault, and jaundice ensue; the lungs may be defective and attendant want of aeration of the blood, with its consequences of livid features, breathlessness, perhaps delirium, may arise.

3. **Vital Causes.**—To this class belong insects such as may infest the surface of the body, skin, hair, &c., and parasites, like the tapeworm and others, found principally in the bowels. These may be the direct exciting causes of acute diseases like convulsions, or slow vague changes classed under general names such as ill health, general debility, decline.

Much more formidable and far-reaching vital causes of disease are grouped under **Contagia** and **Malaria** (see INDEX), which, being introduced into the body, proceed there to develop and multiply, and set up a series of well-known and well-defined processes, having most marked effects upon the body, those agencies, namely, to which the special fevers and all contagious and infectious diseases are held to be due. What the nature of these contagia and malaria is will be discussed when we come to consider fevers.

Besides the exciting causes mentioned under these three classes, there are others, not easily referred to any of them, which are yet directly active in the production of disease, some of which have been referred to also under predisposing causes. Among them are cold, wet, excess or deficiency of food, unwholesome food, bad air, over-exertion, strains, sexual and other excesses.

THE DETECTION OF DISEASE.

There are two ways of gaining information as to the state of health of a person. The first is by learning from the person himself what are his feelings, and by similar information which he alone can supply, and which another person could not learn for himself; the second is by examining thoroughly the body of the patient, first as to its external form and appearance, and then examining, so far as may be, each organ, individually, by aid of hands and eyes and ears, and any instruments which may be devised to help. The indications of disease, signs or symptoms of disease, as they are called, obtained in the first way, from the patient, are called *subjective* symptoms, and those obtained in the second way are called *objective* symptoms. Most of the objective symptoms can be found by one who knows how, quite irrespective of the patient, without his aid, even though he were asleep or otherwise unconscious, and are therefore more valuable and less liable to produce deception. On the other hand, the subjective symptoms being supplied by the patient's own statement will depend on his intelligence and truthfulness. Pain, for instance, is a subjective symptom; and a patient may complain of most excruciating pain when he has nothing of the kind, but feigns it for a purpose of his own; while swelling is an objective symptom, displacement of a bone is another, which would be evident even on the dead body. The collection of all the facts, of all the symptoms, obtained in both these ways, form the basis on which a decision may be made as to the presence of disease and the kind of disease. The gathering of these facts in order to make this decision is called **diagnosis**, and includes everything in the man's life that can establish a key to the disease. A thorough diag-

nosis requires also a view of the person's antecedents (his family history), of his social relationships, and of similar circumstances already referred to in discussing causes of disease.

We shall briefly glance at some of the leading things that should be noticed in the endeavour to form such a diagnosis.

I. GENERAL EXAMINATION OF THE BODY.

1. **Form.**—Look at the outline of the body to detect anything unusual in shape of bones or joints, and compare the two sides of the body. A displacement or break of a bone will be readily seen by the difference between the two sides; swellings, &c., will also in this way be more evident.

Note also "pitting" of small-pox, scars of old wounds or abscesses, especially if over glands, in which case they may suggest a scrofulous taint.

2. **Weight.**—In most diseases weight is affected; and if the person can have a note of several weighings, at regular intervals, it will easily be seen whether weight is increasing—generally favourable—or diminishing—generally serious. The following table gives the proportion of weight to height:—

A man of	4 ft. 6 in.	to 5 ft. 0 in.	ought to weigh	about	92 lbs.
"	5 " 0 "	5 " 1 "	"	"	115 "
"	5 " 2 "	5 " 3 "	"	"	127 "
"	5 " 4 "	5 " 5 "	"	"	139 "
"	5 " 6 "	5 " 7 "	"	"	144 "
"	5 " 8 "	5 " 9 "	"	"	157 "
"	5 " 10 "	5 " 11 "	"	"	170 "
"	5 " 11 "	6 " 0 "	"	"	177 "
"	6 " 0 "	——	"	"	218 "

These weights do not include clothing.

There ought always to be increase in weight up to 45 years of age.

3. **Proportion of Parts.** — Note whether bones, muscles, and fat seem to have their due proportion. Some people "seem all bones:" two men of the same apparent bulk may be very different, the one showing firm, hard muscles, the other being soft and flabby, and evidently more fatty than muscular. These two will stand, obviously, in a very different position as regards disease; the one likely to resist it with vigour and success, the other to be speedily overcome by it.

4. **Colour.**—The skin may be *pale* from deficient quantity of blood or inferior quality, which may arise from improper nourishment (bad feeding, dyspepsia), from loss of blood, or from some disease interfering with the blood (disease of kidney, &c.). Full-blooded persons with a tendency to apoplexy will be florid; *redness* of skin also occurs in fevered states. *Yellowness* is associated with liver disease, and is soonest seen in the white of the eyes. *Blueness* (cyanosis) may indicate disease of the lungs, or may be due to disease of the heart preventing the proper aeration of the blood (p. 258), and is soonest seen on the lips. *Bronzing* occurs in a peculiar affection called Addison's disease.

5. **Dropsical Swellings.** — These most frequently occur soonest at feet and ankles, and can be shown by pressing firmly on the skin with the finger for a short time. On removing the finger, a "pit" remains which slowly fills up. Such a swelling beginning in the face, at lower eyelid, is oftenest due to kidney disease. A prominent appearance of the belly is often due to dropsy.

6. **Expression of Face.**—The face affords most valuable evidence of disease. As regards its colour, see Paragraph 4, **Colour.** In low fevers it may be *dull and expressionless*, in high fevers *flushed and excited.* One side may present a *smooth appearance* without wrinkle, the other may be more than usually *wrinkled and drawn*, indicating paralysis. *Squint* may indicate brain disease; *prominent eyeballs*, goitre.

7. **Attitude.**—The mode of standing, sitting, or disposing of limbs is often suggestive. For example, a patient suffering from acute inflammation of the belly lies in bed with the knees drawn up towards the head, and resists any attempt to stretch them down; a child with spinal disease high up in the neck will keep head, neck, and shoulders stiff and immovable to prevent pain.

8. A point of the utmost importance in detection of disease is the accurate **determination of the amount of heat** of the blood, as indicating the approach or actual presence of fever. This is done very roughly by feeling with the hands the heat of the skin, but this method is never accurate. Often a person will complain of great heat, and seem fevered, when actually the temperature is of the usual amount; while, on the other hand, as in the first stage of intermittent fevers, the person may be shivering and complain of cold, and the skin have all the appearance of cold, when the temperature is actually above what is usual. The only satisfactory way of judging the amount of heat, the degree of temperature, is by means of a thermometer.

The best kind of thermometer is one made for the purpose, called a clinical thermometer (Fig. 1), that is, one for use at the bedside. The figure shows one just about the usual size. It consists of a tube with very thick walls and a very fine bore.

At one end is a bulb (*a*) filled with mercury. On the stem figures are marked 90, 95, 100, 105, 110. These marks are on the Fahrenheit scale. Suppose the bulb be placed in warm water, the mercury in it expands, and, in order to find room, part of the mercury rises in a thin stream up the bore of the tube. Suppose the fine thread of mercury rises to 90, that indicates that the heat of the water is 90 degrees of Fahrenheit's scale.

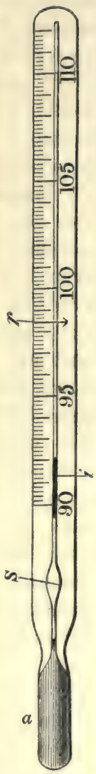


Fig. 1. Clinical Thermometer.

Between the different numbers on the stem there is a series of markings, one set short, the other longer. For example, between 90 and 95 there are 4 of the longer markings. Now each one of these indicates a degree. So that if the mercury stood at the first *long* mark after 90 it would mean 91 degrees, if at the second 92 degrees, and so on. Between these long markings are the short ones, each one of which has the value of $\frac{2}{10}$ths of a degree. Suppose the mercury rose to the first *short* mark after 100 it would indicate a temperature of 100 and $\frac{2}{10}$ths in degrees, that is, 100·2 degrees. If it rose to the *second short* mark past the *first long* one after 100 it would show a temperature of 100 and 1 and $\frac{4}{10}$ths, *i.e.* 101·4, nearly 101½ degrees. The way to use the thermometer is to place it closely in contact with the skin, allow it to remain there for 5 or 10 minutes, and then see how high the mercury has risen in the tube. The most convenient place is the arm-pit, into which the bulb of the thermometer can be easily placed, and the arm folded down tight over it. Now suppose an ordinary instrument were used, as soon as the thermometer was taken out of the arm-pit the mercury would at once, owing to the cold air, proceed to run back towards the bulb, and one would not be able to note how high it had risen. Therefore it would be necessary to note how high it had risen while it was still in the arm-pit. This is often not convenient, and in the clinical thermometer what is called an "index" is used. This is a little piece of the thread of mercury (see Fig. 1, *i*), which has been detached from the rest of the mercury in the bulb and left in the tube, and which the little blown-out part (*s*) prevents being shaken back into the bulb. When the mercury rises it pushes up this "index," and when the mercury recedes the "index" is left standing at the highest point to which the mercury had reached. In the figure the top of the "index"—it is from the top the readings are taken—stands at 92·2°. When the thermometer is to be used the "index" should be shaken down as low as 95°, should it happen to be standing above that. To take the temperature, then, see where the index stands, and, if necessary, shake it down as low as 95°, wipe out the arm-pit, bury the bulb in it, and let the arm be folded tightly over the chest and kept so for at least five minutes. Then take out the instrument, taking care not to shake it, and note where the top of the index is. This gives the temperature, which should be noted down. If it is inconvenient to get at the arm-pit the thermometer may be placed in the mouth well back and under the tongue, and kept there, with the mouth as close as possible, for the five minutes. In children the bulb of the instrument is often pushed up into the bowel, the child being held on the nurse's lap, or it may be even asleep in bed. In this case it would be well first to oil the bulb.

The temperature of the body in health should be about 98·4°, and at this point there is usually an arrow mark on the thermometer (*r*). If the index stands there the heat is normal. There is usually a daily variation, which is slight, the temperature being highest about 9 A.M. and lowest about 3 A.M., but always in the neighbourhood of 98·4°. If the temperature of a person is to any extent above or below 98·4°, it indicates disease, even though the person may have no complaint of any kind. A variation may occur which lasts only a short time and means nothing, but if the high or low temperature is permanent, or frequent, suspicion ought to be aroused. The following table gives the landmarks in temperature:—

Extreme Fever	105° and above.
High Fever	104°
Fever	102·6°
Feverish (slight fever)	100·4°
Normal	**98·4°**
Under normal	97·4° to 96·8°
Collapse	below 96·8°

A temperature of 105° is very grave and could not long be endured, and if it go above that, particularly if it shoot above suddenly, it foretells death almost certainly. About 103° is a common temperature in fevers, measles, scarlet fever, and in inflammation of the lungs, while in ordinary colds, influenza, and so on, a temperature of 101°, and even 102°, is frequent. A persistent temperature of 101° or thereby, with nothing apparent to justify it, should make one suspicious of some concealed disease of the lungs, and should

lead to a consultation with a physician at once. The "collapse temperature," below 96·8°, particularly if previously the temperature has been high and has suddenly fallen so low as this, forebodes death.

The temperature may be made to vary a good deal by the use of hot or cold baths, but the increase or diminution is only for a short time. The administration of alcohol *lowers* the temperature.

The temperature should be taken twice daily, morning and evening, and every day at the same hour in the morning and the same hour in the evening, so that any comparison between different days may be accurate.

It would be well, therefore, for a nurse or other person attending an invalid and observing the temperature to note it down regularly at the particular hour, and, alongside, to place a note of the rapidity of the pulse and the breathing. Thus,

	T.	P.	R.
9 A.M.	102·8°	110	27
10 P.M.	103°	115	29

where T. stands for temperature, P. for pulse, and R. for respirations, both of the latter being the number per minute.

9. Next to the temperature stands **the pulse**. The pulse is usually felt at the wrist, and may be found in a straight line drawn parallel from the inside edge of the forefinger across the ball of the thumb to the wrist. It is due to the movement of the waves of blood driven along the blood-vessel by the contractions of the heart. The things to be noticed about the pulse are:—(1) **Rapidity**, (2) **Regularity**, (3) **Fulness** and firmness.

(1) **Rapidity.**—(*a*) In the young the pulse is more rapid than in the old. At birth it is from 100 to 120 times a minute; at six or eight years of age from 90 to 100; then it gradually declines till in the adult its rate is *between 65 and 75;* and in the aged it is even slower, though in the very infirm it may become faster. (*b*) The number of beats is increased by food, exercise, by rising from the sitting to the standing position, by heat. (*c*) In women, as an average, it is five beats faster per minute than in men. (*d*) It is increased in debility and fever. (*e*) It is slower—sometimes very slow—in brain oppression, for example, apoplexy, opium poisoning, fracture of the skull, unconsciousness from drunkenness.

(2) **Regularity.**—Irregularity, that is, missing a beat, or two or three beats occurring fast after one another and then slower, is not uncommon. It is sometimes due to actual disease of the structure of the heart, but is also very often of nervous origin, and very frequently is due to flatulence or indigestion. Great smokers have sometimes irregular pulse.

(3) **Fulness.**—It should be noted whether the pulse is large and soft—easily compressed—or small and hard. When the former the pressure of blood in the vessel is little, when the latter great. In some diseases of the heart the pulse gives the sensation of small shot passing under the finger.

10. **The breathing** should next engage the attention in the search for disease.

The following table gives the average number of respirations per minute at different ages:—

Age.	Number of Respirations per minute.
Newly-born child	44
1–5 years	26
15–20 ,,	20
20–25 ,,	18
25–30 ,,	16
30–50 ,,	18

In very old people the number may fall to 12 per minute. There should be one respiration to 4 or 4½ beats of the pulse. If this proportion is seriously disturbed it points to some affection of the chest. In disease the breathing may be increased, as in fever and disease of the lungs, or seriously diminished and laboured, as in apoplexy and other diseases of the brain. In opium poisoning the number of respirations is greatly reduced. In fact this is the seriousness of the case, the difficulty of maintaining the breathing. The writer had a case in which the number was reduced to four per minute, and yet the person was restored. **Stertorous breathing** is breathing accompanied with noise in expiration, and is common where the brain is affected. Another kind of breathing in disease of the brain is when the cheeks are sucked in with each inspiration, and blown out with expiration. **Breathlessness** is common in diseases of heart and kidneys as well as in diseases of the lungs themselves.

II. SPECIAL EXAMINATION OF THE BODY.

These more or less general points having been noticed, it is necessary to proceed to a more detailed examination with the hope of finding symptoms which will point definitely to the seat and character of the disease. For this purpose it is advisable to proceed in a regular and systematic order, examining, one by one, each organ or set of organs, and noting anything calculated to aid in the search.

1. **The eye** gives information not only by its colour (see **Colour**, p. 9), but by the size of the

pupil, the round opening in the centre that looks dark. It usually grows larger with little light, and contracts when light is stronger. In some diseases of the brain — inflammatory, for instance, in water in the head, it is widely open and immovable, while in opium poisoning it is extremely small. Squinting, especially if it comes on suddenly, often indicates disease of the brain.

2. **The Tongue, Mouth, and Digestive System.**—The tongue is affected in most diseases. It may be *white and furred*, as in catarrh (common cold), in affections of the stomach, and diseases accompanied with fever. It may be *brown and dry*, as in typhoid and other low fevers; often *red, raw, and glazed* when fever is high. The *scarlet-fever tongue* has red points projecting from the white fur, this is the *strawberry tongue*, so called from its appearance. *Paleness* of the tongue occurs in bloodlessness, and *yellowness* in jaundice. Then in dyspepsia the tongue is frequently furred and flabby, showing at the edges the markings due to contact with the teeth. *Small blisters* on the tongue are frequently due to a bad condition of stomach. In some cases of paralysis the tongue cannot be put out straight in the middle line, but is drawn to one side.

A blistered condition of the gums also will result from stomach disorder; and a bleeding and swollen state of the gums is an occurrence in scurvy.

Grinding the teeth is common not in cases of worms only but in other affections of stomach and bowels.

The state of the throat yields much information in many cases. Sore throat and difficulty of swallowing is one of the earliest signs in scarlet fever. Then it is on the tonsils that the white patches of diphtheria make their appearance.

Connected with the stomach are *pain* and *heartburn* as symptoms of dyspepsia. In ulceration of the stomach a burning pain immediately after swallowing, lasting till the food has passed into the bowels, is common. On the other hand, in some forms of indigestion from weakness and perhaps expansion (dilatation) of the stomach, pain is relieved by food. Again, in cases where there is obstruction to the passage of food from the stomach into the bowels, the pain comes on several hours after food.

The state of the appetite is affected by general diseases as well as by special disease of the stomach. The appetite may be *lost*, as in fevers, or from use of opiates or alcohol, and in congested states of the stomach, constipation, &c. It may be *excessive*, owing to worms, or as in diabetes and various nervous diseases. It may be *depraved*, the person craving for unusual and even disgusting things. This sometimes happens in pregnancy, in mania, and in patients suffering from extreme bloodlessness.

Vomiting is another symptom. When due to deranged stomach it is most frequently accompanied by sickness or nausea. In children between two and seven years of age sudden vomiting, without apparent cause *and not seemingly accompanied by nausea*, is suspicious of brain mischief. Rupture causes vomiting frequently, and in some of the worst cases of it the vomit contains fæcal matters from the bowel. In cases of enlarged stomach, due to obstruction between the stomach and bowels, the patient frequently vomits a great quantity all at once, the stomach having retained several meals in succession, and then ejected them all. In diarrhœa, vomiting and purging go together. Blood may be vomited. Occasionally, owing to the presence of a ferment in the stomach causing the mischief, the vomit tastes very sweet to the person.

The state of the bowels largely determines the condition of the health, and therefore causes of disease are to be sought here, of which costiveness, diarrhœa, and colic are the most common.

3. **In examining the chest** attention should be directed to the heart and lungs. *The place where the heart, in beating, comes in contact with the chest* is usually at a spot about an inch and a half below and to the inside of the left nipple. The place should be noted, as well as the characters of the beat. In some diseases of the heart and lungs the heart is displaced, and the beat is not found in the usual place. Then the *movements of the chest* should be looked to, as to whether they are full and regular, not jerky, as to whether one side moves as much as another, and as to whether, in drawing a full breath, there is a catch (stitch) somewhere. Sometimes the movements will be restricted in one place and unusually marked in another, indicating disease. In inflammation of the lungs the chest may be kept almost stationary, and the breathing performed by movements of the belly. The presence or absence of **cough** and **spit** will give important information, both being severe in bronchitis and inflammation of lungs, while there is no special spit in pleurisy. For methods of examining further the state of the lungs by percussion and auscultation see DISEASES OF THE LUNGS.

4. Next, **the belly** (p. 131) **is to be examined.** It should be noticed whether *its movements* during breathing are natural, whether they are exag-

gerated, as in diseases of the lungs, or restrained by the contraction of its muscles, as in inflammation inside the belly. In the latter case the knees will be drawn up to relieve strain and all pressure on the surface. Even the pressure of bed-clothes will be painful, touching with the fingers being strongly objected to. *The presence of tumours* within, if of any size, will be apparent. *Dabbing with the fingers* in the central line, or a little to the left side, just under the ribs, will be painful when the liver is affected by congestion and other diseases.

5. Under **urinary symptoms** *difficulty in making water*, inability to make water at all, constant dribbling of water (which often occurs not only from want of power to retain the water, but also from retention of water, the bladder being therefore always over-full, and the excess only constantly dribbling away), *pain in making water* owing to gravel, and the place of the pain, &c., all these should be inquired about. In the later stages of fever, particularly in low fevers like typhoid, the patient is unable to make water, that is, retains it, and it should then regularly be withdrawn. Sometimes, as in diabetes, the urine is *excessive in quantity;* in diseases of the kidney it is often *diminished in quantity.* Then its *colour*, and the *presence or absence of sediment,* are important. In jaundice it is highly coloured, of greenish brown, from presence of bile. It is often smoky from presence of blood; while in diabetes it is extremely clear and watery looking. In fever there falls a heavy sediment when the urine cools, which is redissolved by heating it.

6. **The Skin.**—Every one knows what information can be obtained from this source, not only in disease of the skin itself, where each disease has its own special eruption, but in general diseases as well. Thus many fevers have their own *kind of eruption* by which the fever may be distinguished, that of scarlet fever being a general red blush, while in measles spots are raised above the skin.

In some kinds of paralysis the *degrees of sensitiveness of the skin* is important. The *colour* has been already referred to.

The *degree of moisture* of the skin gives valuable aid not infrequently. For instance, the peculiar sour-smelling sweat of acute rheumatism is characteristic, and so are the night sweats of consumption.

The diagnosis of disease, then, is often a very difficult and complicated task, and is properly performed only by a general survey of the body, and a detailed investigation of the different organs, in the manner indicated by the slight sketch already given. Fuller details are, of course, given under the special diseases.

When a diagnosis has been made, and the character and extent of the disease ascertained, it is often possible to estimate what the course and termination are likely to be. This prediction, as it may be called, of what is likely to happen is called **prognosis.**

THE TREATMENT OF DISEASE.

The treatment of disease implies much more than is generally supposed. It is often held to mean simply the administration of drugs; and thus there is put out of count the as important, and often much more successful, treatment by diet, rest, or exercise. Treatment really means the placing of the patient altogether in such circumstances as tend, in the utmost degree, to recovery. From this view of it the administration of drugs occupies a smaller place in treatment than is usually given to it. Taking a wide view of it there are two parts in the treatment of any disease:—1. The General; and 2. the Special.

1. **General Treatment.**—No matter what the disease is, there are certain circumstances that should be attended to as a matter of course. To put a patient in the best possible circumstances for fighting a disease will naturally involve, at the first, *maintaining as well as possible his nourishment.* Now most probably the patient will have no great disposition for food and no great power of digesting it, therefore the necessity of giving food of a kind at once most nourishing and most easily digested. This explains the continual recurrence to milk, which has been well called nature's food, containing, as it does, all the things necessary for the nourishment of the body, in proper proportion. It also explains the preference for liquid foods, such as beef-tea, broths, &c., and for other "simple diets." This all seems self-evident, and requiring no emphasis. Yet it is wonderful how many people not only get themselves into a state of disease by the quantity and richness or indigestibility of the food they take, but maintain themselves in disease by continuing to burden their digestive organs. It is, for instance, almost past estimating how much harm is done to children, not only in health, but when ill, by the mothers allowing them to eat things supposed to be dainties. It is a frequent experience of medical men, especially in dealing with the poorer classes, that some little patient is not recovering with ex-

pected speed, and the doctor is surprised as day after day passes and his treatment is ineffectual, till he finds, on rigid examination, that, without his knowledge, the child is being allowed fruit or pastries. When these have been entirely stopped recovery goes on speedily. The next general point to notice is that, as far as possible, every *help is given to the organs by which waste matters are removed* from the body. If the bowels are not regularly moved, matters will be allowed to accumulate that can only increase the trouble. Similarly if the urine is not voided in sufficient quantity and with regularity, nothing but bad effects can ensue. The same reason shows the *need of pure air*, so that the lungs may perform their part in expelling poisonous substances from the blood; and, for a like purpose, the *skin of the whole body should be kept clean*, so that it may not be sluggish in its duty as a purifier. Thus, at the very outset, in attempting to treat some disease, and even before one can have settled what is the precise character of the ailment, much may be done, in a general way, to put the person in good circumstances for recovery. Proper nourishment, attention to procure regularity of the bowels and kidneys, cleanliness of person and of clothing, freshness of atmosphere, are all most valuable and necessary aids. Then every one knows how a disease may be aggravated by worry, by noise, by excitement. Many cannot understand the agony that may be inflicted by friends in would-be sympathetic calls, or by a cross, careless, loud-tongued, noisy, or excitable attendant. Yet all these things should come into the question of how best to treat the patient.

2. Besides this there is the **special** treatment, in which will be included, in particular, the medicines and other kinds of remedies that may be required. Little need be said on this head except to notice an error that is not infrequent, an error of supposing that disease is some special thing lurking somewhere in the body, having a separate existence, and that, if one only knew it, a medicine might be found which would hunt it out, destroy it, or drive it from the body. Hence many people get impatient because, in spite of drugs, the disease goes on, seemingly unchecked. Now it has been pointed out that disease is generally due to some defect of structure, or some want of proper performance of duty by an organ or organs. Drugs that are given ought, then, to be ordered because of the effect they are known to have on one organ or another, and can only act by affecting the organ in a special way, increasing or diminishing, or altering its action; so that the good that may be done is after all not often directly due to the medicine, but only indirectly through its action on some portion of the body. Drugs can only act by means of the living actions of the body itself; and it is by understanding what these processes are, how disease alters them, and how they may be affected by medicines, that proper treatment of disease will be conducted.

There are various general kinds of treatment that may be explained here.

Preventive, or, as it is called, **prophylactic** treatment, implies the employment of means to ward off a threatened attack of disease. For example, a man who was living in a marshy district and took quinine regularly would be adopting preventive treatment against ague; and the use of lime-juice on board ships, where salt meats are common, and fresh meats and vegetables not attainable, is to prevent the appearance of scurvy.

Palliative treatment is employed to lessen the pain, discomforts, or severity of a disease that cannot be cured, or that must be allowed to run its course. This treatment in a case of very painful cancer would consist in giving opium or morphia, or other drugs, to relieve the pain. A person dying of consumption could have palliative treatment that might reduce for a time high fever, check night sweats, &c., though it might have no perceptible effect on the progress of the disease. Palliative treatment means placing the system under the best condition in the circumstances.

Specific treatment consists in giving a certain prescription for a particular set of symptoms, without knowing how the prescription acts, on the ground of some authority. Salicylate of soda might be counted a specific for acute rheumatism, or, better, mercury for syphilis. "Specifics succeed, but it is not known why."

Expectant treatment might best be explained by the phrase "stand by". There are many diseases which it is impossible to cure, whose progress cannot be arrested, which must be allowed to run their course. All that one can do is to adopt the general treatment as to diet, &c., and then to "stand by", that is, to watch that nothing new arises to interfere with the simple running of its course by the disease, that no complication occurs, or, if it threatens, to endeavour to arrest it. Thus typhoid fever cannot be cured. Once it has begun, it must be allowed to go on till its close, but before that close occurs the patient may threaten to

die of exhaustion. The person who is watching ought to beware of this and take steps to meet and prevent it, if possible. Again, congestion of the lungs may occur, and this, too, can be dealt with. The various special methods adopted in treating disease, such as hydropathy, homœopathy, &c., will best be considered in the part on MEDICINES.

SECTION I.—ELEMENTARY STRUCTURES.

Protoplasm and Cells: *Squamous, Columnar, Ciliated, Globular, Pigment.*
Epithelium: *Its Varieties and Functions.*
The Connective Tissues: *White Fibrous, Yellow Elastic, Cellular or Areolar, Adipose Tissue or Fat.*

In the following sections there will be considered the various organs of the body as they are associated together in groups or systems. One group or system of organs will be taken up after another, each one having a special section devoted to itself. In each section the same order will be followed, viz.: (1.) the **Anatomy**, that is, the structure or make of the organ, will first be discussed, and the **Physiology**, that is, the purpose, duty, or function which the organ, or the group of organs together, ought to perform, will be considered; and (2.) the **Diseases and Injuries** to which the organs are liable, with their symptoms and appropriate treatment, will be examined.

ELEMENTARY STRUCTURES.

First of all, however, it may be advisable to describe here some of the elementary structures that enter into the formation of the various organs of the body.

Protoplasm and Cells.—The ultimate elements of which the body is composed consist of masses, microscopic in size, of a living material called **protoplasm**. In its simplest form, protoplasm is a homogeneous-looking substance, semi-fluid, without apparent differentiation of parts. It may also appear studded with fine or coarse granules, or exhibiting a fine or coarse, more or less irregular, net-work. Often it exhibits little spaces, vacuoles, filled with fluid. In the living state it possesses the power of spontaneous movement, evinced by change of form. Thus at one moment the little mass is more or less spherical, then it becomes irregular in outline by one or more processes of its substance being pushed out. Moreover, by pushing out one process in one direction and retracting another, it can change its place (fig. 2). Now such minute masses of protoplasm are found forming the whole substance of certain microscopic living things. The **amœba** of stagnant pools is such an organism, living an independent life, growing by enveloping with its processes suitable particles in the water with which it comes into contact, building them up into living protoplasm like itself.

Fig. 2.—White Blood Corpuscle. Its successive changes of shape. Highly magnified.

The material fit for its nourishment it builds up, not at a bound but in various stages, and as a result of its activity waste substances are produced. Thus in such a little mass of protoplasm, there are found not only the substances of which the protoplasm properly consists, namely, proteids chiefly, and also carbo-hydrates, fats, and salts, but also other substances, in but not of the protoplasm, lodged in the meshes of its net-work or in vacuoles, some of which are in process of being built up into living protoplasm, while others are the waste products of its activity. Now while there are found, in the lowest realms of animal life, organisms consisting of nothing more than has been described, there are others similar to them, which possess a small body in the interior called a **nucleus**. This is spoken of as **nucleated protoplasm**.

When the animal body is carefully examined, in all the tissues there are found masses of nucleated protoplasm of various sizes and shapes. In all essential features they resemble the structures described. Such bodies are called **cells**. In many of them the nucleus is finely granular or reticulated in appearance, and on the threads of the mesh-work may be one or more enlargements, called **nucleoli**. In some cases the protoplasm at the circumference of the mass is more or less modified, condensed, so that the appear-

ance of a limiting membrane is produced, or **cell-wall**.

A cell then is a mass of nucleated protoplasm, the nucleus may show a nucleolus, and the cell may be limited by a cell-wall. The only essential thing, however, is the living ever-changing protoplasm; and one must ever bear in mind the double process that, while it lives, goes on within the protoplasm, the process of building up lifeless into living stuff, and the process of breaking down by which waste is produced.

Moreover, the amœba we have spoken of multiplies by division, each half thus formed going free as an independent organism, in due time also dividing into two independent organisms. If the animal body be studied in its development, it is found to originate from a single mass of nucleated protoplasm, a single cell, the ovum or egg (fig. 3) showing both nucleus and nucleolus. From this original cell two are formed by division, then four, and so on till a little mass of cells is produced, and from these by further growth and development the animal body with all its various tissues is evolved. This view of the development of living structures was first put forth by two Germans, Schleiden and Schwann, in 1838, and was termed the **cell-theory**.

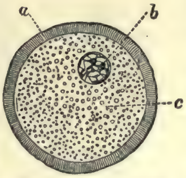


Fig. 3.—Diagrammatic Representation of Ovum.

a, Zona pellucida, or limiting membrane; *b*, nucleus with nucleoli; *c*, protoplasm of cell with numerous granules and fatty globules. (From Klein.)

Many fully formed tissues consist chiefly of cells, notably the liver (see p. 141). In many others the cells have been modified to form fibres, such as tendon, muscle, nerve, &c. In the blood are found bodies, the white blood corpuscles, exhibiting all the characters of the amœba (fig. 2).

Even such hard and dense structures as bone, gristle, and tooth are formed originally from and by the agency of cells.

The cell is therefore the histological unit of the body. By association, combination, and modification of cells, the body is built up. It may also be safely asserted that if the true character of the changes going on in living protoplasm, the building up and the breaking down process, were accurately understood, the secret of life would be laid bare.

Cells vary in size, some being only $\frac{1}{3500}$th of an inch or less in diameter, whilst the largest, the *ovum*, is only from $\frac{1}{400}$th to $\frac{1}{120}$th of an inch in breadth. They also vary greatly in form, as may be seen from the accompanying figures.

The typical cell is more or less **globular** in form, and such are found in glands. A drop of saliva from the mouth will usually exhibit, besides large flat cells, globular cells from the salivary glands.

There are also **columnar cells**, in which the cells are closely ranged side by side (fig. 3*b*, *a*).

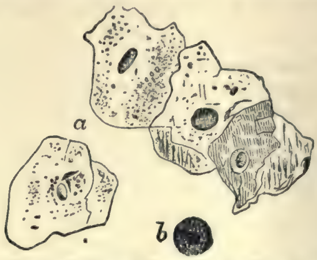


Fig. 3*a*.—*b*, Globular Cell from Salivary Gland, with *a*, Squamous Cells from the Mouth. Highly magnified.

Another form is called **ciliated columnar**, in which the columnar cells have delicate prolongations—cilia—from the free surface (fig. 3*b*). These cilia are, when the cell is living, in constant movement, and when observed under the microscope, present the appearance of the passage of a wave, as is seen when the wind blows over a corn-field.

There are cells of **spindle** shape, cells with numerous branching processes, **branched** or **stellate** cells, cells flattened into a pavement form, **squamous** or **pavement** cells (fig. 3*a*), **polyhedral** cells, and so on.

Besides being thus classified according to *shape*, cells may be designated according to

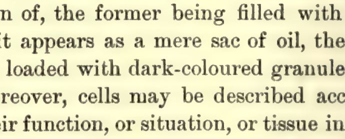


Fig. 3*b*.—*a*, Columnar Cells; *b*, Ciliated Columnar Cells. Highly magnified.

contents. Thus fat cells and **pigment** cells are spoken of, the former being filled with oil, so that it appears as a mere sac of oil, the latter being loaded with dark-coloured granules.

Moreover, cells may be described according to their function, or situation, or tissue in which they are found, as epithelial cells, blood cells, gland cells, nerve cells, connective tissue cells.

The **functions** of cells have been already partly indicated. They manifest vitality in various ways:—(1) absorption of matter; (2) transformation of the same either into protoplasm or some material formed by the cell, such as fat or pigment (colouring matter); (3) separation of waste matters of no further use to

the cell (excretion); (4) growth or increase in size and development of parts by taking up new matter; (5) development of new cells or descendants which succeed the old ones; and (6) special properties, such as that of changing their form or contracting, or that of nervous activity, as shown by the cells of the nervous system. Each cell has a life of its own. Some live for from 12 to 24 hours, as is likely the case with many of the cells lining the alimentary canal, others may live for many years, as in cartilage or gristle and bone. In glands they are constantly engaged in separating various matters from the blood, and altering or elaborating these to form new substances, to be made use of in the body or expelled from it. Thus the cells of the liver form the bile, those of the kidney separate certain substances from the blood, which are cast away in the urine, while those of the salivary glands and of the glands of the stomach and pancreas form the juices by whose agency food is digested.

Epithelium.—Cells are associated and combined in various ways to form simple tissues. Such a simple tissue is called an **epithelium**, and the cells are called **epithelial cells**. The cells are united together by a very small amount of a cement substance. The cells forming an epithelium may be globular, squamous, columnar, or ciliated, and so squamous epithelium, columnar epithelium, ciliated columnar epithelium, and so on, are spoken of. Moreover the cells forming an epithelium may be in a single layer only, or may be several layers deep. In the former case, the epithelium is said to be **simple**, in the latter case **stratified**. It is, then, easy to understand what is meant by **simple squamous epithelium**, and what by **simple columnar epithelium**, and what by **simple columnar ciliated epithelium**. In each case what is meant is a tissue formed of a single layer of cells, but in the first the cells are squamous, in the second columnar, and in the third ciliated columnar. Then there is **stratified squamous**, **stratified columnar**, and **stratified columnar ciliated epithelium**. In the case of stratified epithelia it is the character of the uppermost layer of cells that gives the designation. So that of the three last phrases, the first means a tissue formed of several layers of cells of which the uppermost is squamous, the second signifies a similar structure, the uppermost layer being columnar, and in the third case the top layer is columnar and ciliated. Now such epithelia are found on the whole surface of the skin, lining the mouth, throat, and whole length of the alimentary canal, and all canals communicating with it, lining the air-passages and recesses of the lungs, the nostrils, canal of the ear, surface of eyelids and eyeballs, lining the tubes and recesses of glands, lining all the closed cavities and tubes of the body, &c., and epithelial structures form the essential parts of the terminal organs of the senses.

Fig. 4.—Stratified Squamous Epithelium (Klein). Highly magnified.

Functions of Epithelium.—Such structures may be divided, as regards their function, into two main divisions. One set of them are obviously chiefly protective in character. The layers of epithelium which together form the epidermis or superficial layer of the skin has little beyond such an office to discharge. So is it with the cells covering the mucous membrane of the mouth, and those lining the inner surface of the eyelids and front of the eyeball, of which fig. 4 is a representation. A similar duty belongs to the epithelium lining the air-passages and air-cells of the lungs. Epithelia which discharge so inactive a function are commonly formed of squamous or short columnar cells, and if the situation they protect be much exposed, they are generally stratified. The second great division of epithelia consists of those whose cells are formed of highly active protoplasm, and are busily engaged in some sort of secretion. Such are the cells of glands —the cells of the salivary glands, which secrete the saliva, of the gastric glands, which secrete gastric juice, of the intestinal glands, the cells of the liver, the cells lining the tubules of the kidney, the sweat glands, and so on. Such active epithelial structures are usually formed of a single layer of cells, which are more or less globular in form or long columnar.

Of ciliated epithelium it is necessary to say a further word. The cilia are delicate prolongations of the protoplasm of the cell. They execute a rapid whip-like lashing movement as often as ten or more times a second, and the movement may be quickened or slowed by favourable or unfavourable circumstances. All the cilia move in the same direction. In the case of the respiratory passages, this serves to sweep mucus up the passages; and in other canals a similar valuable office is filled by the ciliated epithelium.

The Connective Tissues.—Under this term

are grouped certain tissues, which to all outward appearance vary greatly from one another, but which are all produced in the developing body from the same parts, and act as packing or supporting structures. Under certain circumstances one of these tissues may be substituted for another, and in certain situations one merges into another. The following is a list of such tissues:—

I. **Connective Tissues Proper:**
  1. **White Fibrous** Tissue.
  2. **Yellow Elastic** Tissue.
  3. **Adipose or Fatty** Tissue.
  4. **Areolar** or **Cellular** Tissue.
  5. **Adenoid, Retiform,** or **Lymphatic** Tissue.
  6. **Mucous** Tissue.

II. **Cartilage** (commonly called Gristle), see p. 23.
  1. **Hyaline Cartilage.**
  2. **White Fibro-Cartilage.**
  3. **Yellow Fibro-Cartilage.**

III. **Bone** and **Dentine** of Tooth (see pp. 17 and 137).

All of these tissues consist of three elements, the proportions of which vary in each tissue, namely, (1) a ground-substance or matrix, (2) cells, (3) fibres. The ground-substance is best seen in hyaline cartilage (p. 23), where it is transparent and glassy looking, but, in the connective tissues proper, it is in small amount, and is obscured by the mass of fibres. In bone, and in tooth, this ground-substance is infiltrated with salts, which give the bone its hardness and make it so seemingly different from the other tissues. In the connective tissues proper the cells are called **connective tissue corpuscles**, in cartilage they are called **cartilage cells**, and in bone, **bone corpuscles.** The fibres are of two kinds, one exceedingly fine, transparent, and running a wavy course in bundles—fibres of **white fibrous tissue**, the other, coarse, yellowish, and elastic—fibres of **yellow elastic tissue.**

White Fibrous Tissue (fig. 5, 1) consists of bundles of very delicate fibrils. In each bundle the fibrils run a more or less parallel course, though wavy. The bundles are bound together by a small amount of cement substance. Associated with them are the connective tissue corpuscles, irregular masses of nucleated protoplasm, often branching, but determined as to shape by the pressure exerted on them by the bundles. They lie on the bundles, in minute passages between them, when the bundles run parallel as in tendon, or they lie in spaces, enclosed by the bundles, when these cross to form a belt work, as in subcutaneous tissue, the loose tissue under the skin. On boiling, white fibrous tissue yields gelatin, and on the addition of a dilute acid the bundles swell up and become cloudy and gelatinous.

Now this tissue is found forming part of various structures, skin, tendon, membranes, loose tissue between and over muscles, beneath skin, &c.; and in these different situations the bundles are variously disposed, parallel in tendon, crossing and recrossing in skin and intermuscular tissue.

Yellow Elastic Tissue (fig. 5, 2) also consists of fibres, which, however, are much stronger and coarser than those of white fibrous tissue.

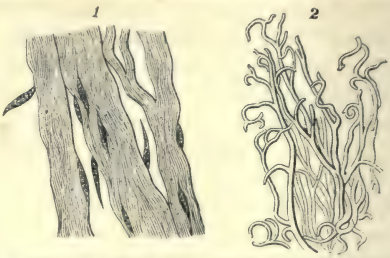


Fig. 5.—Fibres of (1) White Fibrous and (2) Yellow Elastic Tissue. Highly magnified.

They are yellowish, and tend to split and curl up at the ends. They possess a high degree of elasticity. It is these fibres that confers elasticity on the skin, and on the coats of blood-vessels. This tissue is the main component of the ligamentum nuchæ, the broad ligament in the back of the neck of large quadrupeds, for the support of the heavy head. It does not yield gelatin on boiling; acetic acid has no effect on the fibres, and cells are few in it if any.

Cellular or Areolar Tissue is made up of bundles of white fibrous tissue interlacing and crossing one another to form a mesh-work. Numerous elastic fibres are present, conferring elasticity. The two kinds of fibres are easily distinguished, under the microscope, by adding dilute acetic acid, when the white fibres swell up, become transparent, and the unaffected yellow fibres are revealed. The interlacing bundles inclose little spaces or areolæ, hence the term areolar or cellular. Attached to the bundles or lying in the spaces are connective tissue corpuscles and other cells, identical with white blood corpuscles, which have probably found their way, by amœboid movement (p. 15), from the blood-vessels abounding in the tissue. It is a tissue found in large quantities under the skin, covering the muscles, the blood-vessels, and nerves, and in various parts forming a kind of protective covering for delicate and important organs. It is because of its general distribution, and because of its binding various structures together, that it is called connective. The little spaces are filled up with fluid that has oozed out of the blood-vessels.

Adipose Tissue or Fat contains fibres of white fibrous tissue, forming a mesh-work in which fat cells are embedded. These fat cells are round or oval, and consist of ordinary connective tissue cells, in which oil drops have accumulated till the cells resemble little envelopes or sacs filled with oil. The oil may be removed and used up in the body, and then the cells are once more ordinary connective tissue cells. Adipose tissue forms a considerable layer beneath the skin, covers various internal organs, and is found in the marrow of bones and elsewhere. It is protective, in the sense of acting as a packing agent between organs; and it prevents the heat being carried off too quickly from the body, as it is a bad conductor.

Adenoid Tissue is described on p. 201.

Mucous Tissue is found chiefly in the early stages of development. It subsequently undergoes change to ordinary connective tissue. It consists of numerous large branching connective tissue cells, lying in a clear homogeneous semi-fluid mucous substance.

SECTION II.—THE BONES AND JOINTS.

A.—THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Bones: *Microscopical Structure and Chemical Constitution—Periosteum, Endosteum, and Medulla.*
The Skeleton: Head—Cranium, and Face; Trunk; Vertebral Column, description of vertebræ; Thorax; Upper and Lower Extremities.

The Joints: *Structures* that enter into the formation of a joint—Bone, Cartilage, Synovial Membrane, Ligaments.
Kinds of Joints: Imperfect; Perfect—(1) Ball-and-socket, (2) Hinge, (3) Pivot, (4) Shifting.
Kinds of Movements: (1) Angular—Flexion and Extension, Adduction and Abduction; (2) Coaptation; (3) Circumduction; (4) Rotation.

Bones consist of an earthy or mineral part and an animal part. If a bone, say a rib of an ox or sheep, be steeped for several weeks in dilute hydrochloric acid, the mineral matter is dissolved out by the acid, and there remains the animal matter. It retains perfectly the outward form of the bone. It is no longer hard, however, but soft and flexible. On the other hand, if a bone, say the knuckle from a joint, be put into a clear fire, the animal matter is slowly burned away, and only the mineral remains. The bone by the burning first becomes black, and then, as the last trace of animal matter disappears, it becomes pure white. The earthy matter also retains perfectly the shape of the bone, but is very brittle, and liable, at the slightest touch, to crumble to dust. The earthy matter forms about 70 of every 100 parts of the bone, and the animal or organic matter about 30 of every 100, less than one-third. The animal matter is like gelatine; and the earthy consists of phosphate and carbonate of lime, phosphate of magnesia, and chloride of sodium (common salt). In childhood bones contain a larger percentage of animal matter, therefore they are flexible and more liable to bend than to break; while, in old age, they contain a greater percentage of mineral matter, and therefore are more brittle and easily broken.

Usually when a bone is sawn through it is found to have a shell of hard, compact bone outside, and inside the plates of bone are less closely packed, spaces being left between, giving a spongy look. This spongy bone is called **cancellated.** Fig. 6 shows this very well. A

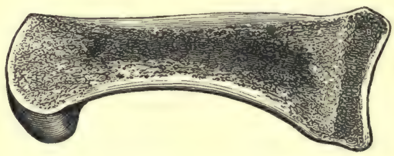


Fig. 6.—Showing dense bone outside, spongy bone within.

long bone has in its centre a cavity called the **medullary canal,** filled with a soft, reddish, pulpy substance, consisting largely of fat cells, and called the **medulla or marrow.**

Bones are usually classified as *Long,* or *Cylindrical,* such as the long bones of the arm or leg, *Short,* or *Irregular,* such as the small bones of the wrist and sole of the foot, and *Flat,* or *Tabular,* such as the bones of the skull.

Bone is completely covered outside by a dense fibrous coating called the **periosteum,** which is richly supplied with blood, and plays a chief part in the growth of bone. The cavity in a bone is also lined with a similar mem-

brane called **endosteum**, also rich in blood-vessels.

The bone itself seems so dry and hard as to have no moisture within it, nor any blood supply; but this is not the case, for blood-vessels pass into it from the periosteum through minute openings, and most long bones have besides a special artery (**nutrient artery**) entering them to carry a due supply of nourishment. If a very thin slice be taken from across a bone and examined under a microscope, magnifying about 300 diameters, an appearance is presented like that shown in Fig. 7, B. Little openings (*a*, *b*) are observed, and round them are ranged rings of bone, with little black bodies in them, from which fine dark lines branch out. These openings are canals cut across, called **Haversian canals**, after Havers, who first described them; the black bodies are spaces, called **lacunæ** (little lakes), in the bony plates, while the fine dark lines are very narrow canals which connect the lacunæ with one another and with the Haversian canals. The narrow channels are called **canaliculi.** A, of the same figure, shows a section taken lengthways, by which the Haversian canals (*a*, *b*) have been opened up, not cut across, and are seen branching and communicating with one another. Now, in these Haversian canals blood-vessels run; the lacunæ contain little masses of a jelly-like material—living protoplasm—processes from which pass along the canaliculi. C, of the figure, shows a lacuna (*a*), largely magnified, with its living mass of protoplasm (*b*). Thus bones have not only a large blood supply obtained from the nutrient artery, and from the periosteum covering the outer, and the endosteum lining the inner, surface, but contain innumerable little cells of living material, which are capable of drawing from the blood the sort of food they require, and thus of maintaining a constant net-work of nourishing channels through the whole bone.

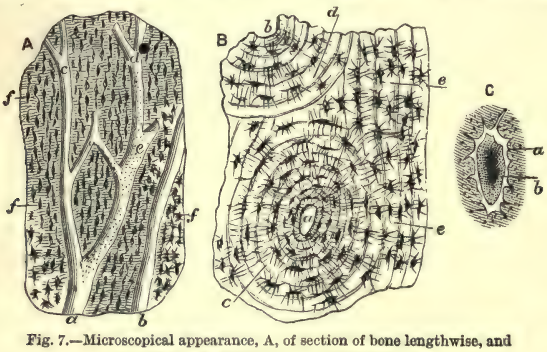


Fig. 7.—Microscopical appearance, A, of section of bone lengthwise, and B, in cross section. C, A bone cell.

Early in the life of the child, months before it is born, there are no true bones in its body, their place being occupied by cartilage (gristle). The masses of cartilage have, however, the shape of bone, and it is out of them the bones are developed. Take such a one as the thigh-bone; it is found that shortly before birth only the shaft has become true bone, the two extremities being still made of cartilage (Fig. 8, A). Just at birth a small deposit of earthy matter is found in the lower end (B. 2), which goes on extending. At one year of age a second deposit is seen in the upper end (C. 3). These little deposits, from which the bone forms, are called **centres of ossification.** The bone formation goes on from these centres till the ends are quite bony, and cartilage exists only at the place of junction between the shaft and the two extremities. The two ends are called **epiphyses,** and may readily be separated at this stage from the shaft. This is an accident which sometimes happens to children, and since it is at this point of junction that the principal growth in the length of the bone occurs, such an accident may seriously interfere with the growth. The union between shaft and epiphyses does not take place till maturity, when further growth in the long direction ceases. Bones increase in thickness by growth from the inner surface of the periosteum. If, by accident or disease, the periosteum be stripped off, no increase in thickness can take place, and the surface of the bone, deprived of its nourishment, will die; and, for a like reason, destruction of the inner lining membrane would impair the vitality of the inner surface. On the other hand the periosteum may be kept in a higher state of activity than usual by constant irritation, as in chronic inflammation. The result will be increased formation of new tissue and thickening of the bone. See DISEASES OF BONE.

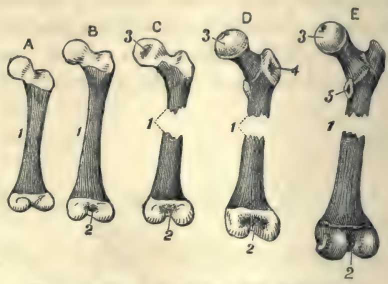
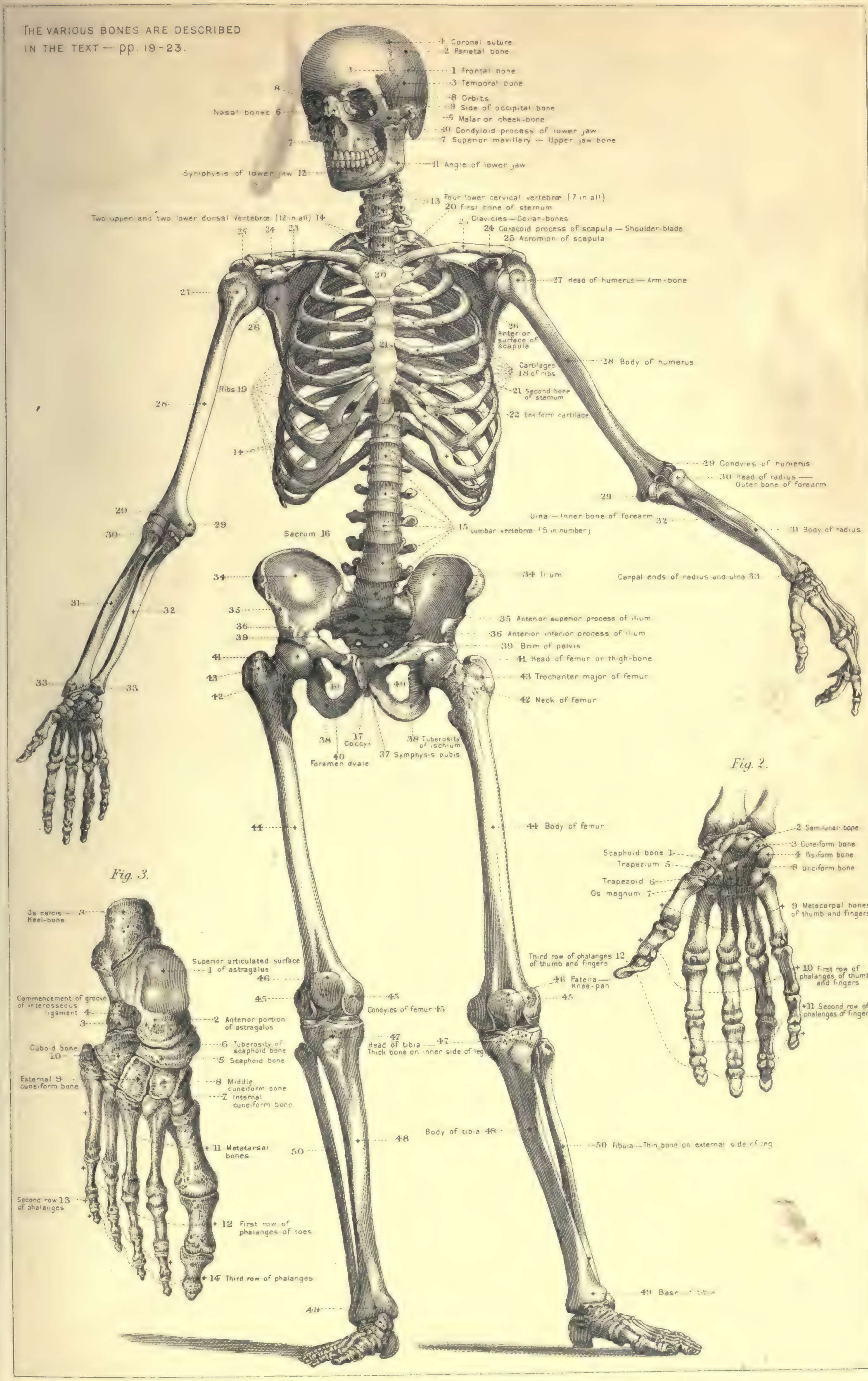


Fig. 8.—Centres of Ossification of the Thigh-bone.

THE HUMAN SKELETON.

Plate 1



THE SKELETON.

The **skeleton** (Plate I., *figs. 1 and 2*) forms the hard framework of the body, and is composed of bones united with one another by joints of various forms, in many cases plates or pads of gristle being interposed between the opposing bones to permit of movement, the union being further strengthened by strong and dense fibrous bands, which bind the one bone to the other.

The skeleton is divided into **head, trunk,** and **limbs,** and is made up of more than 200 bones.

The **Head** includes the part inclosing the brain, called **cranium,** and the **face,** the former containing eight bones, and the latter fourteen.

The eight bones of the cranium are the **frontal,** two **parietal,** the **occipital,** two **temporal,** the **sphenoid,** and the **ethmoid.**

The **frontal** (Figs. 9 and 10, A) forms the forehead and part of the vault of the skull, as well as part of the roof of the sockets for the eye-balls (called the orbits). In children the frontal bone is in two parts, by a division passing down the middle. The **parietal** (B) bones form the great portion of the roof, and meet the **occipital** behind, which completes the roof, and is continued onwards to form a large part of the floor or base of the cranial cavity. The part of the occipital forming the floor is pierced by a large opening called the **foramen magnum,** through which the spinal cord passes to reach the brain. In Fig. 10 O is pointing to the extreme side limit of the occipital bone. The sides of the cavity are closed in by the **temporal bones** (D), one on each side. These contain the organ of hearing. In the figure D′ indicates a downward projection of the temporal bone, which is situated just behind the ear. It is called the **mastoid process.** The gap in the floor of the cranial cavity left by the occipital is filled up by the **sphenoid,** which thus stretches between the occipital behind it and the plates of the frontal occupying the roof of the eye-sockets in front of it. Part of the wing of the sphenoid is seen in the figures, and is marked C; but the main portion is at the base of the skull, and within, and is therefore not seen in the figures. The **ethmoid** is a very spongy bone, is not visible from the outside, and fills up the interval between the orbits. It forms the roof of the cavity of the nose, and is pierced by small openings for the passage of the nerves of smell. *e*, in Fig. 10, shows the side of the ethmoid forming part of the inner wall of the orbit; the other side of the bone is in a similar position on the inner wall of the other orbit.

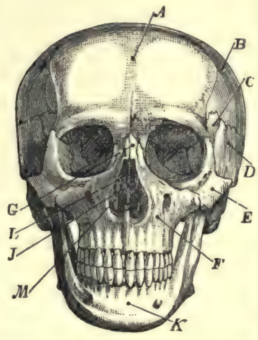


Fig. 9.—The Head, viewed from before.

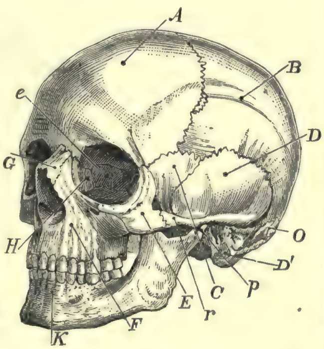


Fig. 10.—The Head, viewed from the side.

The fourteen bones of the face are—two upper jaw-bones (**superior maxillary**), two malar or cheek bones, two **nasal,** two **palate,** two **lacrymal,** two **inferior turbinated** bones in the nasal cavity, the **vomer** or ploughshare, and the lower jaw-bone (**inferior maxillary**). The **upper jaw-bones** (F) carry all the upper teeth, and form part of the floor of the orbit, the rest of which is completed by the **cheek-bones** (E), which also send an arch backwards to join the temporal bone. These arches (**zygomatic arches** *r*, Fig. 10) are the prominent ridges which run out from below the outer angle of the eye to the front of the ear. The **nasal bones** (G) form the bridge of the nose, and at their upper end they come into contact with the **lacrymals** (H, Fig. 10), placed in the inner angle of the orbit, and grooved for a duct, along which the tears pass from the eye to the nose. The cavity of the nose is divided into two by the **vomer** (J, Fig. 9), so called from its resemblance to a ploughshare, which forms a middle wall of partition between the two nostrils, while the **inferior turbinated** are scroll-like bones which project from the wall in the inside of the cavities (M and L, Fig. 9). The **palate bones** are behind those of the upper jaw, and with them form the bony part of the roof of the mouth. The **lower jaw-bone** (K) is the largest of the face bones, and carries all the lower teeth. It is the only bone in the head which is movable, a hinge joint being formed between its strong prominences, projecting upwards (*p*, Fig. 10), and a hollow in the temporal bone under the ends of the zygomatic arch. All the

other bones of the head are immovably connected with one another, one bone presenting a ragged edge, like badly-formed teeth of a saw, the teeth fitting into corresponding notches in the edge of the other bone. These irregular lines of union are called **sutures**.

The **Trunk** consists of the backbone or **vertebral column**, on the top of which the head is supported, and the chest or **thorax**.

The **Vertebral Column** is composed originally of 32 separate pieces, each piece being called a **vertebra**. In the adult state the separate pieces number only 26, several having become fused together. The separate pieces are arranged one on the top of the other, cushions of gristle being interposed between each (Fig. 11, *g*, *g*), which also help to unite them, while the union is completed by partially movable joints and by strong fibrous bands called ligaments. The column so arranged presents two forward curves, the first (*a*) in the neck, the second (*b*) at the lower part of the back, and there are two corresponding backward curves. The first seven vertebræ (1 to 7) occupy the region of the neck, and are, therefore, called **cervical** (Latin, *cervix* = the neck); twelve (from 7 to 19) are the supports from which spring the ribs, and constitute the main portion of the back, being called accordingly **dorsal**; the next five (19 to 24) are called **lumbar**, in the region called the "small of the back." Following these there come five bones, separate in early life, but united in the adult into one piece called the **sacrum**, which forms with the haunch bones on each side a large cavity—the **pelvis**. Attached to the end of the sacrum is a small pointed bony mass, containing four vertebræ, originally separate and of a rudimentary kind, which corresponds with the bony part of the tail in other animals, and is called **coccyx**.

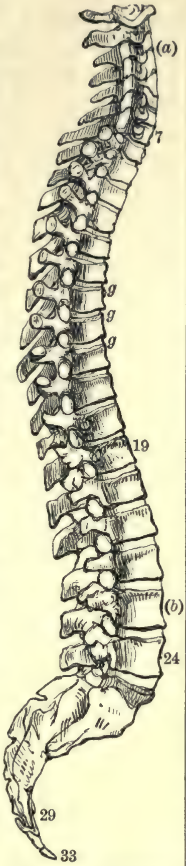


Fig. 11.—The Vertebral Column.

Each vertebra consists of a *body* (Fig. 12, *a*) from which two *arches* pass backwards (*c*, *c*), which meet in the middle line (*b*) and are prolonged into a projection or **process**—the *spinous process* (*d*). The arches inclose a *ring* (*h*). Projecting upwards and downwards from the sides of the ring are processes—two above by which the vertebra is united to the one above it, and two below for union with the one below it. These are called *articulating processes* (*g*, Fig. 12). Just about the position of these, there pass transversely outwards other two projections, one

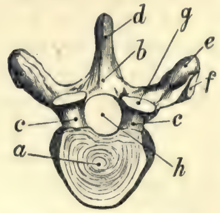


Fig. 12.—A Dorsal Vertebra.

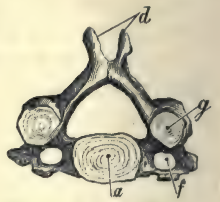


Fig. 13.—A Cervical Vertebra.

on each side, called the *transverse processes* (*f*). Now when the vertebræ are in position the spinous processes are in line. They project backwards—the bodies being in front (see Fig. 11), and give the irregular feeling that is experienced when one passes the hand down the centre of a person's back. At the same time the rings are all one above the other, and so form a canal (*the spinal canal*) in which the spinal cord lies, and by the bony walls of which it is protected. The vertebræ differ slightly according as they belong to the cervical, dorsal, or lumbar region. The cervical vertebræ (Fig. 13) have a canal (*f*) in the transverse process for the passage of an artery, and their spinous processes (*d*) are split at the extremity. The bodies of the lumbar vertebræ are more massive than those of the dorsal. Their transverse and articulating processes are more marked (see Fig. 14, references the same as in Fig. 12), and their spinous processes are hatchet-shaped and point straight backwards, while the spinous processes of the dorsal vertebræ overlap one another, and the transverse processes have little polished surfaces for uniting with the ribs (Fig. 12, *c*). The bodies of the vertebræ are of a different shape in the three kinds, as may be seen from the figures. The two uppermost vertebræ are peculiar. The

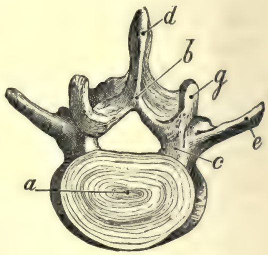


Fig. 14.—A Lumbar Vertebra.

first is called the **atlas** (Fig. 15) because it bears the head. It has very large surfaces (*g*) for a joint between it and processes of the occipital bone, and it is owing to this joint that the nodding movement of the head is possible. This vertebra has no body, but, instead, a small

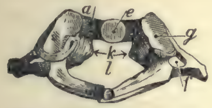


Fig. 15.—The Atlas Vertebra.[1]

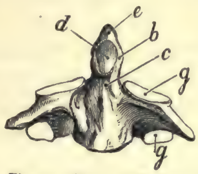


Fig. 16.—The Axis Vertebra.

ring, separated from the large one (*l*) by a strong fibrous band which passes across between the two (see arrow lines in Fig. 15, *k*). The second vertebra is called the **axis** (Fig. 16), because its union with the first is such as to permit a turning movement between them, by which the head is turned to one side or another. This is effected by means of a process called the **odontoid** or tooth-like process, Fig. 16, *c*, *b*, *e*, which springs upwards from the body of the axis and fits into the smaller of the two rings of the atlas. The odontoid process is retained in this position by means of a joint between the surface *e* (Fig. 15) of the axis and the surface *d* (Fig. 16) of the process, as well as by strong fibrous bands, which also prevent it turning too far, and particularly by the ligament already mentioned as passing across between the two rings of the atlas. This ligament, in the living state, intervenes between the process in front of it and the spinal marrow behind it, and if it were to break, the process would crush backwards, destroy the spinal cord at this point, and so cause instant death. This occurs when the neck is broken.

The **Chest or Thorax** consists of the twelve dorsal vertebræ behind, of twenty-four ribs, twelve on each side, which spring from the vertebræ and arch forwards, and of the breast-bone or **sternum** (*o*, *p*, *q*, Fig. 17), to which, by means of cartilages, most of the ribs are united in front. All the twelve ribs on each side (1 to 12 in figure) are not connected with the breast-bone. The first seven have each a separate piece of gristle (cartilage—*c*, *c*) uniting them, and are therefore called "**true ribs**;" the three next in succession are united by the same piece of cartilage, while the last two are quite unconnected with the sternum, and terminate in the muscular wall of the belly. The last five are termed "**false ribs**," the last two (*f*, *f*) being also called "**floating ribs**."

The attachment of the ribs to the vertebræ is by joints which allow of considerable movement, so that the ribs can be elevated or depressed, and thus the cavity which they inclose may be increased or diminished in size. The cartilages confer elasticity on the bony walls of the chest; but in advanced life much of this elasticity is lost by the cartilages becoming brittle owing to a deposit of lime in them, and consequently the chest becomes less capable of movement.

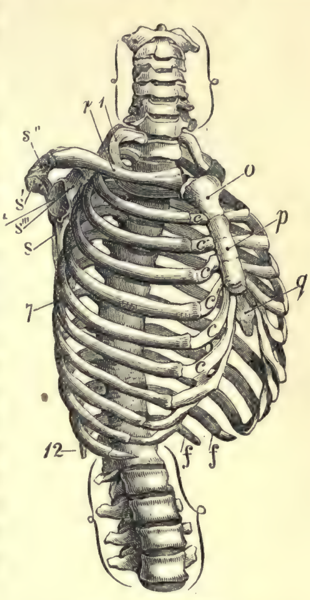


Fig. 17.—The Thorax.

The upper vertebræ inclosed in brackets are cervical, the lower lumbar.

The **Upper Extremity** is connected with the thorax by means of two bones which together receive the name of the shoulder girdle. They are the collar-bone or **clavicle** (*r*, Fig. 17), and the shoulder-blade or **scapula** (*s*, Fig. 17). The **collar-bone** stretches from the top of the breast-bone (*o*, *p*, *q*) outwards, and forms the prominent point of the shoulder. The **scapula** lies on the back of the thorax, where it is freely movable, and is attached to the outer end of the clavicle by strong fibrous bands. It has a strongly developed spine (*s'*) for the attachment of muscles, and two processes (*coracoid s'''* and *acromion s''*, the latter a prolongation of the spine) by which its attachment to the clavicle is effected. At one of its angles it has a polished hollow (the glenoid cavity —*t*) lined with cartilage, into which the head of the arm-bone or **humerus** (Fig. 18) fits, thus forming the shoulder joint. The lower end of the

Fig. 18.—The Humerus.

[1] The position of this figure is different from that of the others. It is the back part that is nearest the person looking at it. In the other figures it is the body or front part that is nearest.

humerus is broadened out by a projection on both the outer and inner sides, the outer and inner **condyles**, and has a pulley-like surface (b) for articulating with the forearm to form the elbow joint. The **forearm** consists of two bones, **ulna** and **radius**. The **ulna** (Fig. 19, 1) is the inner of the two, is large at the upper end, where it has two projections, one, *the coronoid* process (b), in front, and the other, the *olecranon* process (a), behind. Between these two is a deep groove (c) into which the smooth pulley-like surface of the humerus is received, forming a hinge joint. The olecranon behind forms the sharp prominence of the elbow. The lower end of the ulna is slender. The **radius** (Fig. 19, 2) is the outer of the two bones, is small at the upper end, where it is connected with the ulna, so as to permit its head to have a rotary movement, and is large and expanded at the lower end (g), where it forms part of the wrist joint. The arrangement of these joints is such that the radius can roll, as it were, half-way over the ulna. It carries the hand with it, which is thus turned palm downwards—in the act of what is called **pronation**; when the radius is rolled back again the hand is turned palm upwards, that is, the back of the hand is now downwards—**supination.**

Fig. 19.—The Ulna and Radius.

The bones are shown displaced from one another in the figure. The radius (2) is above its proper position. Its head should move on the side of the ulna below the level of the hollow (c).

The **wrist or carpus** (Fig. 20) is made up of two rows of small bones, four in each row. Beginning from the thumb side these bones are named as follows: **Scaphoid** (1), **Semilunar** (2), **Cuneiform** (3) and **Pisiform** (4), in the first row; **Trapezium** (5), **Trapezoid** (6), **Os Magnum** (7), and **Unciform** (8), in the second row. These small bones are allowed a slight amount of movement on one another by means of joints. The **palm** of the hand contains five shafted bones called **metacarpal** bones (m), which means coming after the carpus or wrist. These metacarpal bones support the **phalanges** (p) or bones of the finger. There are three phalanges in each finger, diminishing in size towards the point. The thumb has only two phalanges (Fig. 20, p').

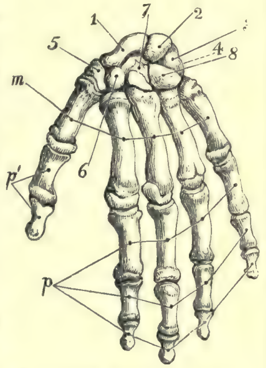


Fig. 20.—The Hand, from behind.

A dotted line leading to 4 shows the position of the pisiform bone, which rests on the cuneiform, and can be seen only from the front.

The **Lower Extremity**, like the upper, is connected to the trunk by means of a girdle called the **pelvis** or pelvic girdle (Fig. 21). The pelvis is formed behind by the prolongation of the vertebral column, **os sacrum** and **coccyx** (S and C). Arching forwards from the sides of the sacrum are two large irregularly shaped bones, one on each side. The name given to each of these bones is **innominate bone** or the unnamed bone. In the figure the lines I on each side of the back-bone indicate the place of union with the sacrum. The innominate bones meet in front at the **symphysis pubis** (sp), a pad of gristle intervening. Each innominate bone consists in early life of three pieces, termed **Ilium** (A), **Ischium** (B), and **Pubis** (C). When the pelvis is looked at as a whole a prominent ring can be followed from the sacrum behind round to the symphysis in front, this is called the brim of the pelvis. The inclosed cavity contains the urinary and generative organs and the lower part of the bowel. In the erect position the pelvis forms an angle of 60° with the horizontal, so that the pressure communicated by the back-bone is thrown, by this inclination, on to the innominate bones. Strong fibrous bands, passing from the sacrum to the part of the innominate bone called the ischium (at the point where the B is placed in the figure), prevent the sacrum from being forced forwards by the pressure. In the pubic portion of the bones is an irregular opening—obturator foramen—(O) through which blood-vessels, nerves, &c., pass outwards. In the innominate bone of each side is a large and deep irregularly formed cavity (a), which is lined with gristle and receives the head of the thigh-bone. It forms a very deep socket; and the thigh-bone has a correspondingly large globular head. This large socket is called the **acetabulum.**

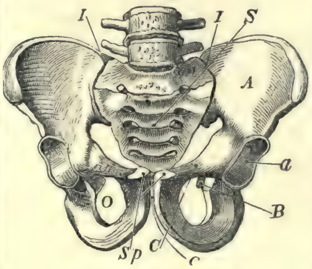


Fig. 21.—The Pelvic Bones.

The **thigh-bone or femur** (Fig. 22) is a very large and strong bone, and presents a shaft (A) with a rough ridge on the back for the attachment of muscles. At its upper extremity, besides the globular head (1) already mentioned, it has two rough prominences, one large and external (2), the other small and internal (3). These are called the **large** and **small trochanters.** The former can be felt just beneath the skin on the outer side of the hip-joint. The lower end of the femur is broad and irregularly shaped, and has two enlargements, one to the inner, the other to the outer side, called **condyles,** and fitted for forming a hinge joint with the succeeding bone of the leg. The leg has two bones, the inner called **Tibia** or shin-bone (Fig. 22, 1), the outer called **Fibula** or clasp bone (2). The tibia is much the larger of the two, and above is connected with the thigh-bone (at *b*) to form the knee joint, the fibula being attached to the outer side of its head. In front of the knee joint, situated within a tendon, is the knee-cap or **patella** (Fig. 22, 3).

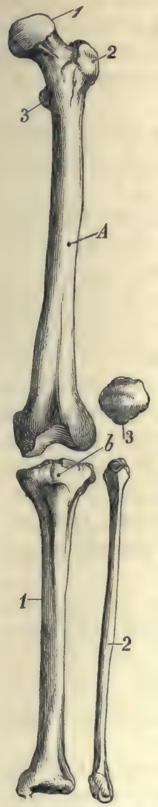


Fig. 22.—The bones of the leg, left side.

The lower end of the tibia and of the fibula enter into the ankle joint, the weight being conducted to the foot by the tibia. The lower end of the tibia projects on the inside of the joint, and the lower end of the fibula has a similar prominent process on the outside of the joint. These processes are termed **Malleoli.**

The **Foot** (Fig. 23) consists of three parts, like the hand, **Tarsus, Metatarsus,** and **Phalanges.** The **tarsus** consists of seven bones, viz.: **os calcis** or heel-bone (1), the **astragalus** or ankle-bone (2), resting above the os calcis and supporting the tibia, the **cuboid** (3), in front of the os calcis, the **scaphoid** (4), in front of the astragalus, and in front of the scaphoid are the **internal** (5), **middle** (6), and **external** (7), **cuneiform.** Like the five metacarpal bones forming the palm of the hand, succeeding the tarsus are five **metatarsal** bones forming the sole of the foot (*m*).

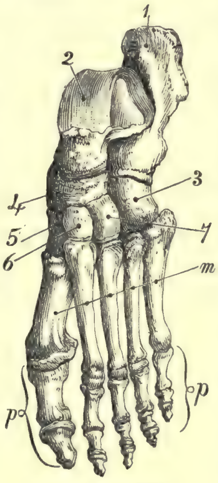


Fig. 23.—The Foot.

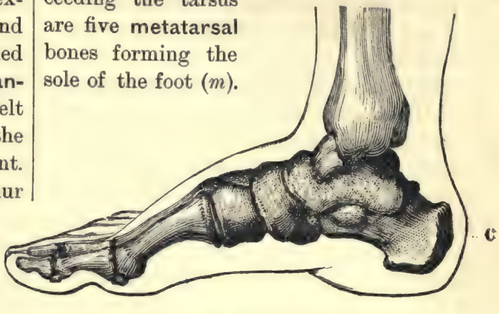


Fig. 24.—The Foot, from the side.

To these succeed the bones of the toes, each toe having three **phalanges** (*p*), except the great toe, which has only two. Here the resemblance to the fingers and thumb is apparent.

Fig. 24 shows the position of the tibia astride of the astragalus, and the great projection behind of the os calcis (c), to which is attached the tendon of the calf muscle. This figure also shows the peculiar arch of the foot, of which the os calcis and the balls of the toes are the piers. It is easily seen how well this arrangement is adapted for supporting the weight of the body.

THE JOINTS.

By **Joint** or **Articulation** is meant the union of two bones by means of other structures. The structures that enter into the formation of a joint are: (1) **bone,** (2) **cartilage** or gristle, (3) **synovia,** a smooth delicate membrane which lines all parts of the inside of the joint except the opposing surfaces of cartilage, (4) **ligaments,** strong bands to bind the bones together.

(1) **Bone** has already been described (p. 17).

(2) **Cartilage.** Hyaline cartilage consists of a ground-substance of a fine ground-glass appearance, containing cells, which have a nucleus and nucleolus, and lie in spaces in the ground-substance inclosed by a capsule. One cell may fill one space, but oftener two, three, four or more cells are present,

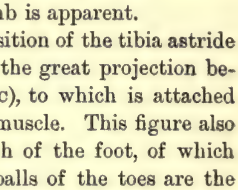


Fig. 24*b*.—Hyaline Cartilage, as seen magnified.

which have obviously originated by division from one original cell (fig. 24*b*).

In **white fibro-cartilage** the ground-substance is everywhere pervaded, and almost replaced, by white fibrous tissue, disposed in layers of bundles, the encapsuled cartilage cells lying between the bundles.

In **yellow fibro-cartilage** yellow elastic fibres form a basket-work, the cartilage cells occupying the meshes.

The first variety is found coating the opposing ends of bones, entering into the formation of a joint (**articular** cartilage), forming the portions of the ribs that become attached to the breast-bone (**costal** cartilage), and it is this kind of cartilage that occupies the place of bone in fœtal life, being afterwards replaced by bone. White fibro-cartilage is found in the discs between the vertebræ of the spinal column; and the third variety forms the main portion of the lid of the windpipe—the epiglottis, and of other cartilages of the voice-box or larynx (p. 262). Cartilage is tough but highly elastic. Disposed between bones it acts as a buffer, while permitting a certain amount of flexibility.

(3) The **Synovial Membrane** is very delicate, and from it a fluid, synovia, is poured out to moisten the cavity of the joint and so reduce the amount of friction and heat developed by movement. It is supplied with blood-vessels.

(4) **Ligaments** are made of bundles of delicate wavy fibres bound firmly together. They are not elastic. They pass from one bone to another, strongly supporting the joint, which sometimes they completely surround.

In a joint, then, you have the ends of two opposed bones, of which the opposing surfaces are coated with cartilage; strong ligaments pass between them to complete and maintain the union; and the inner surface of the joint cavity is lined by a membrane which pours out a fluid to lubricate the joint.

It is, however, only **perfect joints** that are thus fully equipped, and there are joints which want one or other or several of these structures, which are therefore called **incomplete or imperfect joints.**

Imperfect Joints. (1) The bones of the skull are united by their ragged or serrated edges being dovetailed into one another, no structures intervening between the bones. Such joints are called **sutures** and are immovable.

(2) In the union effected between the bodies of the vertebræ there is an example of incomplete joints, which are *partially* movable. Between two opposed bodies of vertebræ there is a pad or cushion of cartilage of the white fibrous kind. The pads are elastic and useful in preventing jars to the vertebral column. Besides, they allow of a considerable amount of movement over all, though very little between any two vertebræ. The union is strengthened by ligaments, but there is no synovial membrane.

Of **Perfect Joints** there are various forms, according to the nature and amount of the movement permitted.

(1) *Ball-and-socket Joints.* In this form one bone has a cup-like depression into which the head of the other fits. This is the kind of joint existing between the head of the arm-bone and the glenoid cavity (p. 21) of the shoulder-blade, and between the head of the thigh-bone and the acetabulum of the innominate bone. In the hip joint the head of the bone is kept close in the cavity by means of a special ligament within the cavity itself, the **round ligament**, which passes from a depression in the bottom of the acetabulum to the head of the thigh-bone. Ball-and-socket joints permit free motion in almost any direction.

(2) *Hinge Joints.* Here the opposing surfaces of the bones have elevations and depressions which fit into one another and allow of movement only in one direction. The elbow, ankle, and knee joints are examples of this kind.

(3) *Pivot Joints.* The best example of this is the joint between the first and second vertebræ, the pivot being formed by the odontoid process of the axis, and the ring in which it is placed being provided by the atlas vertebra. The kind of movement permitted here is rotary.

(4) *Shifting Joints.* In this last kind the amount of movement is restricted and amounts to only a slight gliding between the ends of the bones. The joints between the bones of the wrist and those between the bones of the ankle are good examples.

Besides the ligaments and muscles a force tending to keep bones in joint is the pressure of the outside air. The hip-joint, for example, is so completely surrounded by ligaments as to be air-tight; and the union is a very strong one. If the ligaments be pierced and air allowed to enter the joint, the union becomes at once much less close and the head of the femur falls away as far as the ligaments will allow it.

Joints allow of various kinds of movements, the chief of which are:—

1. *Angular movement,* as when the bones so move as to form an angle between them in the

same line or plane. Angular movements include those of *flexion* and *extension,* as when we bend or straighten the forearm on the arm at the elbow; *adduction,* as when the arm is brought to the side from the extended position; and *abduction,* when it is carried from the side towards the extended position.

2. *Coaptation* is the term applied when one surface glides over the other like a wheel rolling on the ground, so as to bring successive surfaces into contact. This is seen in the movement of the knee-pan on the lower end of the femur.

3. *Circumduction* occurs when the shaft of a long bone describes a cone, the point of which is in the joint, while the base and sides of the cone are described by the moving part, as exemplified by the swinging of the arm when we attempt to make a circle in the air on one side of the body. The same movement can be described by the leg, the joint involved being the ball-and-socket joint of the hip.

4. In *Rotation* the bone moves round an axis, as seen in the movements of the *atlas* on the *axis.* (See p. 21.)

Section II.—THE BONES AND JOINTS.

B.—THEIR DISEASES AND INJURIES.

Diseases of Bone:

Inflammation (1) of Bone itself (*Ostitis*), and how it may end in Death of the bone (*Necrosis*), Suppuration (*Abscess*), or Ulceration (*Caries*); (2) of Periosteum (*Periostitis*); (3) of Endosteum (*Osteomyelitis*).

Spinal Curvature—Posterior and Lateral.

Rickets.

Softening of Bone.

Tumours of Bone.

Diseases of Joints:

Inflammation of Joints—Synovitis—Dropsy—White Swelling—Chronic Rheumatic Inflammation—Hip-joint Disease—Housemaid's Knee.

Hysterical Affections of Joints.

Injuries of Bone:

Fracture: General Considerations—Causes, Kinds, Mode of Union, Non-union, Signs, Treatment.

Special Fractures of Skull, of Bones of the Face, of Lower Jaw, of Collar-bone, of Shoulder-blade, of Upper Arm, of Forearm, of Wrist, of Palm of Hand, of Fingers, of Spine, of Ribs and Breast-bone, of Pelvis, of Thigh, of Kneepan, of Leg, of Bones of the Foot.

Injuries of Joints:

Dislocation: General Considerations—Causes, Kinds, Results, Signs, Treatment.

Special Dislocations of Spine, of Lower Jaw, of Collar-bone, of Shoulder-blade, at Shoulder, Elbow, and Wrist Joints, of Thumb and Fingers, at Knee and Ankle Joints, and of Bones of the Foot.

Sprains. See page 79.

DISEASES OF BONE.

I. Inflammation.

It has been seen that bone has blood-vessels passing through its substance in great numbers, and that it is coated without and within by membranes—periosteum and endosteum—which also are richly supplied with vessels. Bone is, therefore, liable to the changes that occur in inflammation. It is also easily understood that the disease may attack (1) the substance of the bone itself, or (2) the periosteum, or (3) the endosteum and the cavity containing the marrow, which it lines. In the first case the inflammation is called **ostitis**, in the second **periostitis**, in the third **osteomyelitis**.

1. Inflammation of Bone itself (*Ostitis*).

Course.—(1) Increased quantity of blood and the enlargement of the blood spaces, which are the earlier occurrences of inflammation, cause the bone first of all to become less dense, more porous, and therefore lighter, softer, and more fragile. (2) But succeeding this is a stage of thickening, when material which has passed through the walls of the inflamed blood-vessels becomes organized to form new tissue. In this tissue bone salts become deposited, and thus quantities of new bone are formed which fill up the spaces of the healthy bone and render it more hard, and dense, and thick. Should the disease not be arrested at this point other consequences may follow. (3) The continued inflammation may cause suppuration and the for-

mation of an abscess. The matter may be collected at one place in the bone; but, in cases of persons of very bad constitution, the matter may extend all through the bone. (4) Ulceration may occur, in which the bone breaks down or may be said to melt down into unhealthy matter, which works its way to the surface and bursts. It may burst into a joint. As the ulceration continues there is a constant discharge through the opening that has been formed. This ulceration in bone is called **caries.** It is not likely to result from inflammation of bone in persons of good habit of body, but is liable to occur in persons, and specially young persons, whose constitution is tainted with scrofula. It occurs oftenest in the spongy part of the bone, and particularly in the heads of the long bones, and in short bones like those of the wrist, or foot, or the vertebræ. (5) The bone may die, not in minute particles, as in caries, but in pieces, either in a thin slice from the surface or a complete portion of the whole thickness of the shaft may die. This mode of termination of inflammation is called **necrosis,** and the dead piece is called a **sequestrum.** When part of the shaft of a long bone has died in this way it is not uncommon for the periosteum (from which, as already mentioned, the growth in the circumference of the bone proceeds) to produce a layer of new bone, so that the dead portion becomes encased within a shell of new material.

This disease may be acute or chronic. It is in the chronic cases that very great thickening, caries, or necrosis will result. It often extends over years with intervals of rest between attacks. It occurs oftenest in the young, and in the bones of the head and of the thigh or leg (femur or tibia). It is usually attributed to cold, but the chronic forms may be due to constitutional disease like scrofula or syphilis.

Symptoms.—The first sign is violent, deep-seated pain, worse at night. There is high fever ushered in by shivering. In a few days there is swelling of the leg in the neighbourhood of the diseased bone, the skin becoming red and boggy to the feeling. The health suffers rapidly and severely, the patient often sinking under the violence of the attack. If an abscess forms in the bone there is often severe fixed pain at one particular spot which nothing relieves. When caries or necrosis has occurred there will generally be one or more openings through the soft parts which refuse to close. In *necrosis* this open channel, **sinus,** as it is called, will lead down to the dead bone, and a probe being passed in the right direction will touch it and give a rough, grating, and metallic feeling, sometimes the piece being felt to be loose in the cavity. In *caries*, thin, ill-smelling matter will issue from the opening, the edges of which are red and pouting, and a probe gives the sensation of softness and grittiness, the bone breaking down under the touch.

Treatment.—This is a disease that may be extremely severe, and may kill with great rapidity, and therefore, wherever possible, qualified medical aid should be obtained.

For acute inflammation the limb must be kept absolutely at rest, the person being in bed. Warm cloths should be employed, and several leeches applied over the inflamed portion. Opening medicines, such as salts, seidlitz, &c., should be given, and the person kept on low diet, no rich stimulating foods or large quantities.

If, however, the disease is chronic, especially when due to scrofula, the patient requires strengthening food and tonic medicines—good food, with change of air, sea-air being best, cod-liver oil, and tea-spoonful doses of syrup iodide of iron repeated twice or thrice daily. The part affected may be blistered or painted over with iodine. The agonizing and continuous pain over a special spot due to an abscess in the bone can only be relieved by an operation by which the bone is cut into and the matter allowed to escape. This, of course, only a surgeon can do.

When caries or necrosis has resulted, the strengthening and tonic treatment is specially necessary. The discharge is nature's method of removing the diseased portions of bone, but it is a tedious method under which the sufferer may sink. It is, therefore, often advisable, and sometimes necessary, that the diseased portions should be removed by a surgical operation.

2. **Inflammation of the Periosteum** (*Periostitis*). It has been noted how richly this outer fibrous coating of the bone is supplied with blood, and also how growth of the bone in its thickness is due to it. It can, therefore, be seen how seriously the bone may be affected by diseased conditions of the periosteum.

The **course** of the disease is similar to that of inflammation of the bone proper. (1) Owing to the great increase of blood growth will be excessive, and there will be considerable new formation of bone beneath the inflamed membrane. The thickening may, should the inflammation pass off, gradually diminish and become absorbed. The thickening may be so great as to amount to

an actual bony tumour projecting outwards to a greater or less extent. In this case it is called an **exostosis.** The thickening of the bone will of course be of limited extent, and the result may be to produce distinct elevations or **nodes** of the bone, easily felt, and sometimes seen through the skin. (2) The disease may go on to suppuration. This may be very serious, for the matter will collect underneath the periosteum, between it and the bone, separating the one from the other. Should the separation continue for any time, the matter not being allowed to escape and the membrane not allowed again to become applied to the bone, then the surface portion of the bone from which the separation has been made, being deprived of its nourishment, will die and (3) necrosis results. Instead of necrosis, however, there may be (4) ulceration of the surface of the bone—caries—determined by the bad constitution of the person. Periostitis occurring near a joint may extend into it.

The disease may be acute or chronic.

The **causes** of the acute form are cold and injury. Acute periostitis is often caused in school-girls by a wetting, the wet clothes knocking against the legs and so exciting the disease. The chronic form is due to constitutional diseases like scrofula, syphilis, rheumatism, or gout. The scrofulous form attacks children specially, the parts oftenest affected being the sparely-covered bones, for example, those of the head, the collar-bone, and those of the leg (tibia) and arm (ulna). Syphilis is the most frequent cause of the chronic forms, and specially leads to the formation of limited thickenings and nodes.

Excessive use of mercury is also a powerful agent in the production of this kind of inflammation.

Symptoms.—There is fever, high pulse, loss of appetite, &c. The person complains of intense pain in the affected part, which is increased by pressing on the place and is aggravated at night. Care should be taken not to attribute this in children to growing pains, or in older people to rheumatism. After a little time the part becomes swollen, and the skin over it red and glazed, which again is liable to be confounded with erysipelas (Rose, St. Anthony's fire).

Treatment.—A. *For acute attack.* (1) Rest in bed, the affected limb being *raised* on pillows. (2) Low diet—milk, &c. (3) Saline purgative medicines—salts, seidlitz, &c. (4) Put several leeches over the affected part, and after they come off use warm fomentations. After the acute attack has passed off the patient may be very low and exhausted, when nourishing food and tonic medicines (such as tincture of Peruvian (cinchona) bark, half a tea-spoonful several times daily to a child), and sometimes wine are needed.

B. *For chronic forms.* Paint the part with iodine, or use small blisters. If the disease be due to scrofula, cod-liver oil is necessary, or chemical food, if to syphilis, it must be treated as for syphilis. For both syphilitic and rheumatic periostitis probably iodide of potassium will be best; and it may be given in five to ten grain doses in water twice or thrice daily (for an adult). If a collection of matter has formed, which deep-seated constant pain will indicate, the only remedy is an incision to let out the matter. This cannot be done by inexperienced persons.

3. **Inflammation confined to Inner Lining Membrane** (*Endostitis, Osteomyelitis, Medullitis*). This is a rare affection, and when it does occur it is generally after amputations, or owing to bullets, &c., being lodged in the cavity of the bone.

II. Spinal Curvature.

The bones of the back-bone are, equally with other bones, liable to inflammation and its various consequences; but here the results are much more serious and much more marked. It is usually the bodies of the vertebræ, in front, that are attacked. They get softened and break down, in fact ulceration (caries) of the front of the bodies takes place. A large portion, therefore, of the body of one or several of the vertebræ gets scooped out, the intervening cushions of gristle suffering as well. The result of this will be obvious. The vertebral column transmits the weight of the body downwards. In consequence of this weight, therefore, the softened vertebræ will get crushed together in front, and bending of the backbone will result, a projection behind being formed. (Fig. 25.)

Fig. 25.—Disease of the Spine.

1. This is called **Angular** or **Posterior** (backward) **Curvature of the Spine.** It is also called Pott's Curvature, after an English surgeon, who first described it as a separate disease. When the vertebræ have thus become crushed together

the disease may cease, and a cure be effected by union taking place between the bones, though this may take two or three years. Not infrequently, however, this crushing together has a fatal effect. The spinal cord is inclosed within the spinal canal formed for its protection. When the curvature occurs the bending may produce pressure upon the cord, and death may be due to its being crushed. Death is, however, generally due to exhaustion.

The broken-down matter of the bones is often of very considerable amount. Like any other fluid it will seek the lowest level, and so will work its way through cellular tissue and between muscles until it is able to reach the skin, where it points in the form of an abscess. There are several special places where these abscesses make their appearance, places determined by the position of the disease, of which the chief are (1) low down in the back—lumbar region—forming **lumbar abscess,** and (2) at the upper portion, and in front, of the thigh, forming **psoas abscess,** from the name of the muscle over which it lies. The abscesses, instead of coming to the outside, may burst into the lungs, or into the spinal canal, or into the cavity of the belly, &c., and so cause death.

Signs.—The disease progresses slowly, and at its commencement the symptoms may be very vague. A peculiar awkwardness and stiffness of walk and carriage may first be noticed about the person. When he stoops to lift something from the ground the back is held stiff instead of curving round. There is loss of sprightliness and elasticity; and the person walks, moves, sits down, or rises up in a way to prevent jars. Jumping or a high step is avoided, great distress being often occasioned by a sudden slip. It often begins with symptoms due to pressure on the spinal cord, causing irritation, such as weakness, coldness and numbness of the legs, and perhaps twitchings, and even paralysis. The digestion is disturbed; the bowels are costive; and if the disease be high up among the dorsal vertebræ the breathing is difficult and distressed, sudden and shooting pains being complained of through the chest and abdomen. There are several ways of obtaining symptoms of the disease. If it is suspected in a young child it should be stripped and laid across the knees, face downwards. When the knees are slowly separated the spinal column is slightly lengthened out, pressure is taken off, and the child will give signs of relief. Then bring the knees together again, place one hand on the top of the head and one on the buttocks, and let the hands push against one another. The vertebræ are pressed together, and the child shows signs of pain. Tapping with the knuckle down the back, over the spinous processes, will often produce a sudden shrinking of the body from the touch when the place over the diseased part is struck. Similarly when cold and hot sponges are passed alternately down the back, distinct shrinking occurs on passing the seat of disease. Children do not so much complain of the spinal tenderness, but with adults the tapping produces a dead sickening sensation. When the vertebræ of the neck are affected the head is held very stiffly, and not moved sideways, the person preferring to turn the whole body. There will be difficulty in supporting the head, which the patient steadies with his hands.

Finally there is the appearance of a small knuckle of bone projecting somewhere in the line of the spinous processes, which goes on increasing.

Treatment.—The object of treatment is threefold: (1) to give rest to the spine, in the hope that the disease may begin to mend when the irritation, constantly occasioned by the slightest movement, is removed; (2) to give support to the spine, so that, by removing the weight from the diseased bones, the crushing-in process may proceed as little as possible; and (3) to support the strength and increase it as far as may be, since lowness of health is a feature of the disease, and death by exhaustion one of its not infrequent terminations. Now, formerly, the first two of these conditions were fulfilled by keeping the sufferer strictly confined to a bed or sofa, lying on the back. The objection to this is manifest; it impaired seriously the patient's vigour, and, if anything, aided the progress of the affection. Mechanical means of fulfilling the conditions naturally enough were resorted to, and various complicated kinds of apparatus have been invented and used for the purpose. These, however, were so cumbersome as to be irksome and borne with difficulty by those who could afford them at all, while they were quite beyond the reach of the poor owing to their cost. A few years ago, however, a method was devised by Professor Sayre of New York, which entirely fulfils the conditions, is not attended by the objections mentioned, and has produced in many cases marvellous results. Simply stated it consists in applying to the patient's body from the hips to the arm-pits a continuous bandage of plaster of Paris, which, when "set," ought to be quite hard and stiff, and so affords a perfectly adjusted and close-fitting support. Next the

skin the patient has a tight-fitting knitted worsted jersey. The bandages are of wide-meshed material, into which the fine plaster of Paris is rubbed dry, and the bandage then rolled up into a regular roll. The bandages are placed, end up, in a basin of water, five or ten minutes before being required for use. In order to stretch the spinal column and take off from it all pressure, before the bandage is applied, the patient is suspended by the head and shoulders, so that the tips of the toes just touch the ground. The apparatus by which this is done consists of a tripod, which suspends a pulley (Fig. 26). Passing over the pulley is a cord, one end of which has attached to it a cross-bar. From the bar there hang two well-padded slings, one of which is placed under the arm-pit of each side, and there is also a padded circular strap which supports the chin and back of the head (Fig. 27). When the slings and strap are adjusted the patient can be raised, or can even raise himself, by pulling on the other end. The same sort of apparatus could be employed without the tripod by means of a hook screwed into a roof or door-sill. On the patient, thus suspended, the bandage is applied on the top of the jersey. Beginning below just over the hips, the operator winds it regularly upwards, turn after turn, till the arm-pits are reached. To make it stiff enough several layers will be necessary, requiring perhaps 25 to 35 yards of bandage. After one layer is complete it is well to cover it with a cream-like paste made of the plaster of Paris and water, putting it on and smoothing it over with the hands. Another layer of bandage and another quantity of the paste are then used, and so on. Still further to strengthen the plaster, strips of perforated tin about the length and breadth of corset whalebone or steel are introduced at the sides and back, and additional layers of the bandage over them. The tin is perforated because the rugged edges of the holes cause the strips to "grip" well. When sufficient of the bandage has been put on, the patient is carefully lifted down from the suspending apparatus, not being himself allowed to move the slightest degree, and, being kept quite straight, is laid down so on a hard mattress on the floor to allow the plaster to "set" thoroughly. This probably will be accomplished in half an hour. Then he may put on his clothes and go about. Very often the application of this bandage has enabled persons to walk who were previously quite helpless.

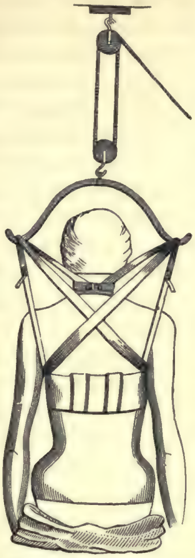


Fig. 26.—Suspension Apparatus for use in Spinal Disease.

Fig. 27.—Slings, &c., of Suspension Apparatus.

When the disease is high up in the dorsal region, or in the cervical region, an additional arrangement is necessary for the support of the head. It consists of a light piece of iron fixed by the bandage to the back, and projecting upwards as high as the head. From the top of it a piece of iron arches directly *over the head,* and from this arch straps are suspended for supporting the head by the chin and occipital bone behind.

When the bandage is being put on a pad ought to be placed over the stomach to be removed after the plaster has "set" over it. It leaves room for the distension of the stomach with food. Even the presence of an abscess on the back need not interfere with this method of treatment. For, after hardening, an opening or window can be cut in the jacket at a marked point exactly over an abscess, allowing of its being regularly dressed.

Besides this mechanical treatment there is the constitutional—good nourishment in plenty, fresh air, cod-liver oil, Parrish's chemical food, or other syrup of the phosphates of iron and lime, and other tonics.

Any abscesses that may appear in the course of the disease require to be opened, to let the matter escape, and treated in the ordinary way (Refer to Abscess. See Index.)

The practice of making and keeping up issues, by the use of caustics, at the side of the backbone is not now so frequently followed as formerly.

2. **Lateral Curvature.** This is not a dis-

ease, like the former one, attended with serious destruction of tissues. It is due to a relaxed state of the body, to greater development of muscles on one side than on the other, or to weakening of one side, which some special employment might give rise to; or it is due to the adoption of a peculiar attitude, such as "standing at ease" on the right leg with the left knee a little bent, or to an attitude assumed in writing or at needlework, specially if the person be short-sighted. Nurses who carry children always on the same arm are liable to it. It is sometimes the result of chest disease, pleurisy, or of one leg being shorter than the other. It attacks girls between the ages of ten and fifteen, particularly those who grow too fast for their strength.

Signs.—On uncovering the whole back the curve of the backbone is observed to follow the outline of the italic *f*; one shoulder is higher than another, and one shoulder-blade projects. The right shoulder is usually the high one, and the left is depressed. Similarly while one hip, usually the left, projects, the other is curved inwards (Fig. 28). There may be other symptoms, due to the deformity causing oppression of breathing, or pressure on the nerves producing pains.

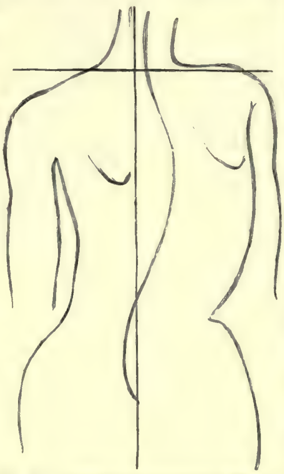


Fig. 28.—Lateral Curvature of the Spine.

The **treatment** is not dissimilar to that of the former disease. Mechanical support by the plaster-of-Paris bandage may be used, the unnatural attitudes being, as far as possible, discarded. But special benefit will be derived from strengthening food, from the use of medicines already advised for posterior curvature, and from the patient being caused to take regular exercise, and to have a moderate course of gymnastic exercise. If a tripod, &c., such as used for the plaster bandage, is available the patient should swing herself from it for about five or ten minutes every morning, just lifting herself from the ground. Cold bathing, particularly cold sea-water bathing, is of great use. The patient should not sleep on a feather-bed but on a firm mattress, and should rise early.

III. Rickets.

This is essentially a disease of childhood, and makes its first appearance when the child begins to walk, about the eighteenth month after birth. It may come on in any of the earlier years of childhood, but it never occurs after twelve years of age. It is particularly the children of old or feeble parents, or the later children of a large family, and the children of the poor, ill fed, and living in small, badly aired, and ill-lighted houses, that are most liable to the disease.

Its **causes** are thus either inherited feeble constitution, or an inherited constitution actually scrofulous, and bad and insufficient food, want of fresh air and light.

The chief defect in the bone is absence of the due proportion of animal and mineral matter. the mineral matter—lime salts—being deficient, so that the bones are soft and yielding. Besides this the process of development in the bones is more slow than is usual, and some stages of it are exaggerated, so that not only is there diminished quantity of lime salts, but also increased formation of the soft material, viz. cartilage cells. When at last the bone salts begin to be deposited the formation of bone is apt to advance with greater than normal rapidity, and to extend further than usual, so that the bone becomes denser and heavier than ordinarily.

The **chief sign** of rickets is the deformity which the soft and yielding nature of the bones occasions. As soon as the child begins to walk, the bones of the leg are unable to support the weight of the body, and so bend outwards. The pelvis, similarly, is crushed in by the weight of the back-bone and its cavity narrowed. This is specially serious in female children, for the pelvis retains its contracted form up to adult life, and so may obstruct or render impossible natural childbirth. The chest may be deformed owing to the ribs yielding to the force of the muscles that take part in breathing. Thus the sides of the chest are drawn in and the front projected, and the *pigeon breast* is formed. The bones of the head also partake of the disease, producing the peculiarly large head and protuberant forehead, while the face is small and peaked. In addition, the spine may also be curved, the joints are large and prominent, especially those of the wrist and ankle, causing the appearance called by some people "double-jointed," the growth over the whole body is generally stunted, so that the stature is small, the face is pale, and digestion imperfect. The child is often pot-bellied; the soft spot on the

top of its head in front is larger, and later of closing, than usual; and teething is delayed.

In its early stages the disease frequently reveals its onset by the restlessness of the child during the night, a tendency to kick off the bed-clothes, and profuse perspiration about the head, and a painful sensitiveness over the whole body, so that the child objects to be touched. About the age of fifteen the bones often become quite firm, and a process of repair sets in, by which the hollows in the bones due to the bending may become filled up. Thereafter the excess of bone may be absorbed, and so the deformity become greatly diminished.

Treatment must be directed to improving the general health. This is to be accomplished by giving good and sufficient food, milk, animal food, raw eggs, by exercise, and by attention to the clothing to see that it is clean and warm, flannel being preferred. Change of air and sea-bathing are very valuable. As to drugs, the best are cod-liver oil and chemical food, given thrice daily in quantities to suit the age of the child, and iron, of which the most suitable form is dialysed iron, 5 to 10 drops four times daily in water.

To prevent the growing deformity of the legs various contrivances exist. The simplest is a wooden splint well padded and strapped on the outside of the leg from the thigh to the foot, which keeps the leg straight and strengthens it till it becomes able to bear the weight of the body. There are others, more complicated, made of steel fastened to the boot, and jointed at the knee so as to permit of bending. These are specially useful when the yielding is mainly at the joints, and not so much due to bending of the bones. There is now in use an operation for curing deformity due to the bending. It consists of cutting out a wedge-shaped portion of the bone, and then fixing up the limb, straight, as for fracture, and keeping it thus till the ends have completely united. It is employed only after the bones have become hard.

IV. Softening of Bone (*Mollities Ossium*).

This is peculiarly a disease of elderly women, especially those who have had large families. It consists in a softening of the bone owing, seemingly, to the lime salts being dissolved out of the bones, and then cast out of the body in the urine. It affects usually nearly all the bones of the body, but specially those of the pelvis.

The **signs** are those of general ill health, the patient complaining of weakness and weariness, and specially of aching pains over the body, settling down in the bones about to be affected. The bones grow soft and readily break, turning in bed being sometimes sufficient to cause fracture. The patient becomes bedridden, and may continue so for years till sheer exhaustion ends the suffering.

The **treatment** can only be general—nourishing food, cod-liver oil, rest, and warmth—no special treatment being known that is of any avail.

V. Tumours of Bone.

These are outgrowths from the bone, and may consist of fibrous substance, of cartilage, of bony substance itself, or of cancer.

The **Fibrous Tumour** is usually connected with the periosteum, especially of the jaws.

The **Cartilaginous Tumour** has its favourite seat on the fingers and toes, and the great toe in particular. It is a heavy, round, smooth tumour of varying degrees of consistency. When it occurs within the bone it usually bursts it up, and this is accompanied with great pain. It is sometimes associated with cancer.

Bony Tumours usually consist of a simple increased development of ordinary bone, either spongy bone, or hard and compact; and sometimes it is of ivory hardness.

The most common form is called **exostosis,** and is found at the ends of long bones near the joints. It also forms readily in connection with the skull, inside or outside. When it is within it may produce convulsions, insanity, and other nervous diseases. The outer angle of the eye is another seat of exostosis. A bony tumour is generally inconvenient and awkward, owing to its size or position, but, with the exception of that of the skull, not hurtful unless it presses seriously upon nerves or blood-vessels.

Bones are the frequent seats of **cancer,** the upper jaw, the lower end of the femur and upper end of tibia and fibula being peculiarly liable. The cancer may begin within or without the bone. When it begins within it causes wasting of the bony substance around till it is covered by only a fine shell of bone, which at last breaks, and a fungus-like mass sprouts out. It is characterized by rapid growth, by severe, wearing, rheumatic pain, disturbing the sleep.

The **treatment** of bony tumours need only be alluded to. Those that are harmless, such as fibrous, cartilaginous, and bony, had better be left alone unless they come by pressure to cause serious disturbance. If interference become

necessary amputation is generally required. With cancer amputation is the only possible treatment.

DISEASES OF THE JOINTS.

I. Inflammation of Joints.

The most delicate part of a joint is the synovial membrane, which pours out the synovia or fluid lubricating the joint (p. 24). It is liable to inflammatory changes, in which the amount of blood flowing through the vessels of the membrane will be increased, the membrane will be swollen to some extent, and the amount of fluid it pours into the joint will consequently be augmented. This constitutes—

1. **Inflammation of the Synovial Membrane** (*Synovitis, Dropsy of Joints*) in one of its acute forms. Beyond this the disease may not pass, but the inflammation may subside, and the excessive amount of fluid be absorbed. On the other hand, it may proceed to a more severe form, when the membrane becomes very full of blood, and greatly swollen, the edges being fringed with pulpy deposits formed by the material poured out by the blood-vessels. Suppuration may occur, and the fluid of the joint become mixed with matter, or a regular abscess may exist in the joint, while the ligaments become thick and swollen. The disease may extend to the cartilages, producing dulness and cloudiness of their substance. In chronic cases the cartilages are more seriously concerned, the continuance of the inflammation causing them to become softened or ulcerated, or parts of them may die so that they may be peeled off in large or small pieces, the bone they cover being also affected. The condition in which the synovial membrane has passed into pulpy degeneration is called **white-swelling**.

Symptoms.—Corresponding with this difference in the severity and acuteness of the attack is the nature of the symptoms. In the simple acute case you may have an otherwise healthy man complain of a stiffness of his joint—generally the knee-joint. The joint is seen to be swollen, and if one hand rest on one side of the joint and the other side be tapped by a finger of the other hand a feeling of a wave passing through the joint will be experienced. This is called *fluctuation*, and signifies the presence of fluid in the joint. This accumulation of fluid invariably alters the shape of the joint—an alteration which may easily be observed by comparing the affected joint with the sound one of the opposite side. The swelling is most prominent at the least-covered portions of the joint: in the knees it is seen at each side of the patella, which is projected forwards: at the elbow-joint it is above the olecranon process, and between it and the projection on each side of the arm-bone: in the case of the ankle the fulness is at each side of the joint. There is some pain, but little fever or serious general disturbance. In the severe cases of the acute form, however, the pain in the joint is very great, and aggravated by the least motion. The swelling is great, the skin over the joint being red and tender; and the fever is often very high and severe. The patient lies in bed with the leg bent and turned outwards, and all the muscles are on guard, as it were, to prevent any change in that position. The swelling and puffiness extend to the leg. In the chronic forms, where the cartilages are ulcerated or partly dead, besides a dull, aching pain, worse at night, and swelling, &c., there will be sudden startings of the limb, which may occur while the patient is asleep and awake him. This is always a symptom characteristic of degenerative changes occurring in the joint. The occurrence of shiverings, a high range of temperature, and severe sweating indicates the formation of an abscess in the joint. In abscess as well as in ulceration the matter may burst through the joint, work its way among the soft parts to the surface, through which it breaks, and an opening or openings are left from which the matter escapes.

The **causes** of the disease are exposure to cold, blows, strains, wounds, or mechanical injuries. Besides these purely local causes, there are others which are constitutional, such as rheumatism, gout, venereal disease, and blood-poisoning (pyæmia).

The **treatment** depends on the acuteness of the attack. In the simple case, first mentioned, rest, the knee being supported on a soft pillow, and hot fomentations, will likely be sufficient. To promote the absorption of the fluid, painting with tincture of iodine or the placing of a small blister on each side of the joint is all that is necessary. In severe cases, to ensure absolute rest the limb must be put up in splints. A long one, carefully padded, should stretch beyond the joint both ways, and be fixed by straps at some distance from the joint. Then put on six to twelve leeches round the joint, and hot fomentations a short time afterwards. It is often better, especially if the inflammation is the result of a wound and has lately occurred, to put at once a large ice-bag over the joint. In such a case pound the ice, put it in an india-rubber bag,

and place it over the joint, *having a moderately thick piece of flannel between the bag and the skin.* The ice-bag may be kept applied for hours in this way. Then give purgative medicine, Epsom or seidlitz salts being preferable. At night twenty-five drops of laudanum may be given to relieve the pain *if the person be an adult.* When the acute stage has passed away the swelling is to be got rid of, as before, by blisters, iodine paint, and the pressure of a tightly and well-applied bandage. Splints must not be left too long on, lest the joint become permanently stiff or its range of movement interfered with by the formation, within the joint, of bands of new tissue crossing it and preventing movement in certain directions. The stiffness or partial union of a joint by such bands is termed **false anchylosis.** To prevent it, as soon as the splint can be taken off, which time can only be judged of according to the patient, the joint should be manipulated by some one and moved gently backwards and forwards for a few moments several times a day.

Where disorganization of the joint (**white-swelling**) has taken place the limb must be kept straight by the splint, and the patient's strength supported by food, cod-liver oil, &c., in the hope that the joint will become permanently fixed, which is the best cure to be looked for in the case. A surgical operation, and even amputation of the limb, is frequently in such cases necessary.

Permanent rigidity of a joint is called **true anchylosis.** When it is sought for as the best cure care ought to be taken to place the limb in the most favourable position for use after union has taken place. This position, for the hip and knee, is straight, for the elbow it is at a right angle.

Where an abscess has formed in the joint an opening should, of course, be made to permit the matter to escape.

When the inflammation is due to rheumatism, gout, &c., the treatment for these diseases should be adopted. (See RHEUMATISM, GOUT, &c.)

2. **Chronic Rheumatic Inflammation** (*Chronic Rheumatic Arthritis—Rheumatic Gout*) is a disease supposed to be due to rheumatic or gouty tendency, and occurs frequently in elderly persons, generally women. In it all the tissues of the joint are altered, the lining membrane being thickened and fringed, the cartilages being removed, the bone becoming bare, dense, and hard, and its surface polished. At the same time the head of the bone gets flattened out in the joint, and masses of new bone (exostosis) grow out and surround the joint, producing often great deformity.

The hip-joint is most often affected.

Symptoms.—Pain is the first sign, worse in cold weather—pain that is racking, wearying, gnawing. The deformity of the joint and the masses of bone projecting from its sides can sometimes be felt. The joint is stiff, and its movements often accompanied by a creaking, grating sound. Going down and up stairs when the hip is affected is attended with difficulty and increased pain.

Treatment.—The best local remedy is heat applied by fomentations, or, best of all, hot baths—vapour or Turkish. M. Gueneau de Mussy strongly recommends arsenical baths made in the following manner:—15 grains of arseniate of soda, with ½ lb. of carbonate of soda, are added to 30 gallons of water at a temperature of 98° Fahr.; and twelve such baths are taken—for the first four every second day, and afterwards daily, the patient remaining in the bath for from seven to ten minutes. These baths sometimes produce marked improvement, the suppleness of the joints increasing after every bath; sometimes slight diarrhœa, temporary excitement, and sleeplessness result. Sulphuret of potass may be used in the strength of 4 oz. to the 30 gallons of hot water, and the same number of baths taken as above recommended. Sulphur ointment is sometimes used as an application to the affected joints, more especially where a single joint is suffering; or a lotion of equal parts of glycerine and of the tinctures of iodine, opium, and aconite may be used, the joints being wrapped in flannel after the ointment or lotion has been applied.

Damp houses should specially be avoided. The patients should keep themselves warm, and constantly wear woollen clothing.

In reference to general treatment the diet must be carefully attended to, no heavy pastry or puddings made with suet being allowed, plain food being most suitable, at regular intervals, so that the stomach is allowed sufficient rest.

The state of the bowels should also be carefully regulated. For this purpose the Carlsbad salts, sent home in bottles, or the artificial salts, may be used. The artificial are made by combining equal parts of sulphate, phosphate, and bicarbonate of soda, of which a teaspoonful is taken in half a tumblerful of lukewarm water in the morning. Friedrichshall water or Hunyadi Janos may be taken instead of the above,

a claret-glassful slightly heated being generally sufficient to produce the desired effect.

The most commonly-used medicine is iodide of potassium, of which 3 grains dissolved in water may be taken thrice daily for several weeks. A mixture that has obtained great credit is made of guaiacum, sulphur, and potash, as directed in the recipe for gout. (See APPENDIX OF PRESCRIPTIONS.)

3. **Hip-joint Disease** (*Morbus Coxæ*). The nature and progress of this disease are the same as those described under INFLAMMATION OF JOINTS. The hip-joint, however, is most often attacked, and particularly in children. It is a very troublesome and misleading disease, and very often overlooked in its early stages, when it is most easily treated, and therefore should be specially noted. It is commonly due to injury.

Symptoms.—The child is affected with slight lameness, and drags one leg. This is most noticeable in the evening after the fatigue of walking or standing all day. When the child is stripped, placed standing on a chair, and is looked at from behind, the pelvis of one side is seen to be drawn up and only the toes of that side touch the ground, or the foot is turned on edge and rested on the side of the other foot. When the child is laid on its back on a firm, flat surface the affected limb is bent at the knee, while the sound one lies straight out. When the bent knee is pressed flat on to the ground, the back at once becomes arched. If the child be then turned on its face the buttocks of the affected side seem flattened and wasted. In the beginning the pain is often slight and occasional, then it increases, and may be felt all over the thigh. In the later stages it is often felt chiefly at the knee, and this is apt to draw away attention from the hip. The pain may be brought out by pressing behind the trochanter—the projection of bone felt at the side of the hip—or in front over the joint in the groin. The most delicate test for the pain is to lay the person on the back, take the foot in the hand, the leg being bent at the knee and the thigh being bent up towards the body, the limb being at the same time turned away from the middle line, and in this position turn the foot gently outwards. The muscles usually fix the limb so as to prevent movement at the affected joint.

Besides these special symptoms, those of starting at night, &c., already mentioned under INFLAMMATION OF JOINTS, are present.

Treatment.—The treatment already described for diseased joints—splints, cod-liver oil and tonics, &c.—is applicable here. But a special kind of treatment has also been devised for not only keeping the joint at rest, but also for removing the pressure from the head of the bone. It is called the treatment by continuous extension (Fig. 29). A broad strip of adhesive plaster (*a*) is applied to each side of the lower part of the leg by its ends in such a way that the long loop of the plaster extends beyond the heel. The strip

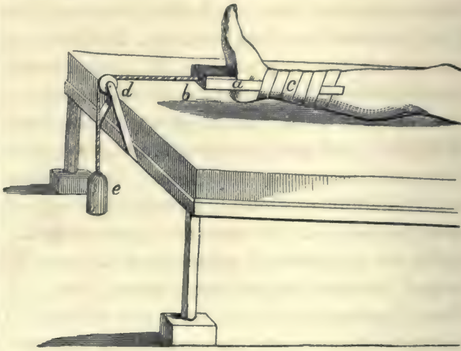


Fig. 29.—Continuous Extension.

is secured by bands of plaster (*c*) round the leg. The loop is attached to a square piece of wood placed under it, and resting against the sole of the foot. From the centre of the wood stretches a cord (*b*) which passes over a pulley (*d*) attached to the foot of the bed. From the end of the cord hangs a weight (*e*) sufficient to keep up extension of the limb. The amount of weight is best judged of by the patient himself, but it should not be less than 10 lbs. It may be slowly increased, and should be kept on night and day. While this treatment is going on strengthening food, &c., must not be forgotten.

4. **Housemaid's Knee.** See under DISEASES OF MUSCLES, BURSÆ, &c.

II. Hysterical Affection of Joints.

This is not uncommon in girls from twelve to fifteen years of age, and in women at the middle period of life. It occurs in people of nervous temperament. Frightful pain is complained of, but the joint presents no appearances—redness, swelling, &c.—to account for it. One must not be deceived by appearances, which may have been produced entirely by poultices, blisters, or liniments. The general health remains excellent in spite of the serious disease complained of; sleep is not disturbed. It will usually, however, take a skilful surgeon to determine whether it is a case of hysteria or actual disease. The treatment will, of course, require to be directed to the nervous condition. (See HYSTERIA.)

INJURIES OF BONE.

Fracture.

General Considerations.—A fracture is a break in a bone, and is more accurately described as "a solution of continuity."

Its **Causes** are of two kinds—Predisposing and Exciting.

Predisposing causes include the *age* and *sex* of the patient. It is easily understood how age affects the liability to broken bones. In youth the animal matter abounds, so that bending is more likely to occur than breaking. In old age the mineral matter abounds, and, therefore, the bones are more brittle. In infancy, accordingly, the number of fractures is less than at any other period of life. The number increases about the ages of seventeen and twenty-five. The greatest number, however, occurs after forty. Men are more liable than women.

Besides these there are causes arising from disease. Certain *constitutional diseases* increase the risk, such as scurvy, syphilis, and especially rickets.

Local diseases, that is, diseases affecting the bone itself, also predispose, such as inflammation, tumours, softening, ulceration, wasting, &c. These act by diminishing the resistance of the bone.

Exciting causes are those which actually produce the fracture, and are of two kinds—(1) *Violence*, (2) *Muscular Contraction.* (1) The *violence* may be applied to the limb directly or indirectly. Thus when a cart-wheel passes over a man's leg it breaks the bone by direct violence; a blow from a stick breaking an arm would also be a case of direct violence. But when a person jumps from a height, though he lands quite rightly on his feet, he may break one of the bones of his leg by the violence—the sudden strain—communicated upwards. This would be indirect violence. Similarly a man thrown from his horse frequently breaks his collar-bone, though nothing has touched the clavicle itself. (2) *Muscular contraction* is not, of course, so common a cause, though sudden violent contractions of a muscle may break the bone to which it is attached. It is the severe muscular contractions that occur in fits that are most liable to do this. Violent coughing in old people may break some of the ribs; and this would be a case of muscular contraction.

Kinds.—(1) *Simple.* Here the bone is merely broken at one point, straight across or in a slanting direction.

A simple fracture may occur either in the shaft of the bone or at the extremities. When it occurs at the extremities it may separate the ends—epiphyses, as they are called—from the shaft, with which they have not yet been completely united. This, of course, can happen only in persons whose development has not been completed. It is never found after fifteen, and seldom after eight, years of age. Separation of epiphyses is called **diastasis**.

(2) *Compound.* This implies not only that there is a bone broken, but also that a wound exists *which leads down to the break from the outside.* It is not sufficient that a wound exists in the neighbourhood of the fracture; it is only where that wound opens externally and communicates with the place of fracture that the case is properly one of compound fracture. Now this wound may be made in two ways: (*a*) from without, as when the violence applied outside has both caused the wound and produced the fracture; and (*b*) from within. In the latter case the jagged ends of the broken bone may, by movement, have been forced through the muscles and skin till they appeared externally. Again, an abscess may have formed at the seat of fracture, and the matter may have burst out and so made an opening. Or the ends of the bone may not have been properly set, and may have pressed against the muscles and skin until they caused an opening to take place by ulceration. The compound fracture, where the wound is due to the bursting of the jagged ends through the tissues, is likely to be less dangerous than that in which the wound has been produced from without. For, in the latter case, the bruising and damage done to the soft parts are liable to be much more extensive.

(3) *Comminuted* fractures are those in which the violence has been sufficient to break part of the bone into fragments. A comminuted fracture may also be compound, that is to say, the bone may have been broken to pieces, and a wound may exist leading from the seat of fracture to the outside. This is liable to occur, for instance, when a railway-carriage has passed over a limb.

(4) *Green-stick* fracture is the name applied to the incomplete break occurring frequently in the bones of children. If a fresh sapling be violently bent it will break only half-way through, one side being broken, the other only bruised. So in children the bones are soft and pliable, and one side, the convexity of the bend, may be broken, the other only bruised and compressed.

(5) *Impacted fracture* occurs at the end of long bones when the shaft is driven up into the head of the bone. In such a case some of the signs of fracture are absent. There will be no unnatural degree of movement, for example.

Mode of Union.—The first step in the process of repair consists in the pouring out from the blood-vessels of the bone and its outer and inner lining membranes of a fluid and cells capable of forming a consistent tissue. This tissue becomes at first fibrous, then cartilaginous, and finally is transformed into bone. The material which thus unites fractures is called **callus.** When the fragments have not separated from one another, but remain in their proper position, the callus is formed only between the two ends, where it is called **permanent callus,** and, as **internal callus,** in the marrow cavity, which it completely fills up. But when the bones have separated, and have not been properly replaced, the repairing material is exuded from the blood-vessels in sufficient quantity to fill up the gap between the two fragments, and to surround the two ends completely so as to form a clasp. When this has become converted into bone a bridge of new bone connects the fragments, and a ring of new bone encircles them for some distance above and below the place of fracture. The portion that acts the part of ring does not remain permanently. It exists for the purpose of keeping the broken bone at rest until a union has been accomplished between the ends. When that has been effected much of the encircling callus is absorbed. For this reason it has been called **provisional, external,** or **sheathing callus.** The time which elapses before complete union has taken place varies according to the age and strength of the person, and also according to the size of the bone, the accuracy of the adjustment of the fragments, and the degree of perfectness of rest permitted to the part. The usual time, however, is from four to ten weeks. But the process does not end here. As soon as rigidity has been obtained the sharp edges of the bone begin to be smoothed away, and any bone that has been formed in excess of what is necessary for purposes of union is slowly absorbed. By absorption also the inner layers of new bone change from dense to spongy bony tissue, and the marrow cavity is cleared of its internal callus. The last stage may be completed in from six to twelve months.

Non-union.—Some bones do not readily unite at all by bony union. They are generally bones which, from the position they occupy, and owing to the action of the muscles attached to them, do not get sufficient rest to permit of the reparative process going on in all its stages. As a result the callus never reaches the stage of true bone, but stops short at the fibrous or gristly stage. This is specially liable to occur in repair of the neck of the thigh-bone, the olecranon process of the ulna, the processes of the shoulder-blade, and very particularly the knee-pan. In the union of any bone, however, such an arrest of development may take place. It may be that the person is not in vigorous health, and therefore the repair is tedious or incomplete. Frequent meddling by the attendant, or constant movement by the patient, will produce a like result. The occurrence of suppuration or death of a portion of the bone, a thing likely enough to occur in a compound or comminuted fracture, would also interfere with perfect repair. In such cases ligamentous may take the place of bony union, or the ends of the bone, remaining separate, may become rounded off, covered with a glistening fibrous tissue, and inclosed within a kind of fibrous sheath, so that a **false joint** is formed, which permits of free movement.

Signs.—Naturally the first signs of fracture are *pain* and *loss of function*—the person cannot use the broken limb. In a short time there will also be *swelling* and *discoloration*, due, first of all, to the blood from the torn blood-vessels, and, next, to the material that exudes from the vessels for repair. It is of great value to be able to examine the limb before the swelling sets in, as it may mask some of the most important distinguishing signs of fracture. The most important signs are—(1) *unnatural capacity of movement* at the site of the fracture; (2) a peculiar crackling sensation called *crepitation*, which may be felt by the hand placed over the fracture, when the opposed surfaces of the broken bone grate upon each other; (3) *deformity*, caused by the displacement of one of the fragments. (1) The unnatural power of motion is most generally present, though when the break is near a joint it may be difficult to distinguish it from the ordinary movement of the bone in the joint. It is one of the main distinguishing features between fracture and dislocation, the limb being, in the latter case, deprived of its natural power of movement. (2) Crepitation is obtained by trying to move one end of the broken bone on the other, and conveys a sense of rough, coarse grating to the hands. It cannot be discovered if there be any degree of swelling; it may not be obtained when the broken bone is alongside of another, which

supports it and prevents the necessary movements. For instance, if, in the forearm, the radius were broken, the support of the ulna would prevent crepitation. (3) Deformity is, above all others, the most important sign. Deformity is due to displacement, generally of the more remote of the two fragments. The displacement may have been effected at the moment of fracture by the violence which caused it. It is frequently produced by the muscles attached to the bone, the natural tension of the muscles causing them to pull away the part, and making it project in some unusual manner. The weight of the fractured limb, beyond the injured part, is also a frequent cause. Thus, if the thigh-bone be broken, the foot will act as a lever, displacing the lower fragment outwards. The displacement may be of different kinds: (*a*) Displacement by riding, in which one end lies over the other. (*b*) Angular displacement, where the two ends are not in the same straight line, but form an angle. (*c*) Displacement by turning. An instance of this has been given already, viz., in fracture of the thigh-bone the weight of the foot turns the lower fragment outwards. There is, therefore, rotation of the lower fragment. (*d*) Lateral displacement, in which one fragment moves to the side of the other, keeping parallel with it, and without losing its grip of the other fragment. Most of these displacements can be conjoined. Thus riding can coexist with rotation, &c. Besides the signs already mentioned, another may be noted, viz. *shortening* of the fractured limb. This is not always present. When it does occur it is due to displacement, one fragment overriding the other and so causing the apparent shortening. To detect this, as well as to detect swelling and deformity, a comparison must be instituted between the sound limb and the limb supposed to be broken, and measurements taken to determine any difference in length.

In *impacted fracture* unnatural movement and grating will be absent, and deformity and shortening will be the chief signs.

Distinction between Fracture, Dislocation, and Bruise.—It has been said that in dislocation the movement is diminished instead of increased, the dislocated bone being unnaturally *fixed;* and there is no crepitation. In a bruise there will be pain, swelling, and loss of function as in fracture, and the swelling may be so great as to prevent a proper examination. In such a case the limb should be kept quiet, supported, and hot cloths applied till the swelling subsides. Then it will be found that if there be merely a bruise and no fracture, there will be no unnatural motion and no crepitation.

Treatment.—*Temporary Treatment.* It often happens that a person receives a fracture and has to be carried some distance before being regularly attended to. In such a case it is extremely desirable that the broken limb should be so fixed that dangling is prevented and no movement permitted. If this is not done there is great risk that the ends of the broken bone, moving about freely among the muscles, nerves, and blood-vessels, may do damage much more serious than the original break, and may even force their way through the tissues, causing a wound, and so converting a simple into a compound fracture. To prevent this is easy. The limb should be rendered immovable by placing on each side something rigid. A walking-stick or umbrella, in the absence of anything else, would do. Bark stripped from a tree, pieces of wood torn from a paling, and so on, would, for the time, equally answer the purpose. Whatever is employed should be secured by straps, which may be obtained from handkerchiefs, or strips of cloth torn from some article of clothing. Then, if the thigh or leg has been broken, after it has been rendered immovable in this way the person should be placed on a stretcher, or whatever can be got in its place, in such a way that the *whole* of the injured limb is supported. If, for instance, the foot and part of the leg were left projecting beyond the stretcher, they would act as forces dragging the broken parts asunder, and every step of the carriers would communicate great pain to the sufferer. In order further to support the broken leg it might be placed alongside the sound one and strapped to it.

Systematic Treatment.—There are two main conditions to be fulfilled in the treatment of fracture: the first is to restore the bone to its natural position, and the second is to retain it in that position till it can have time to heal. (1) Restoring of the bone to its natural position, or the **reduction of the fracture**, is best effected by considering what are the forces that tend to displace the bone. The forces are particularly muscular, and it is, therefore, necessary to grasp the limb—that part of it which carries the lower fragment—and pull it firmly but steadily in a direction opposed to the muscles that displace and in the axis of the limb. This is called **extension**; and, along with it, what is termed **counter-extension** must be employed, which consists in fixing the upper fragment so that

it may not be pulled on also, and may afford a firm position from which the lower fragment may be extended. As soon as sufficient extension has been practised the ends of the bone must be brought together, so as to fit as accurately as possible. It is done by keeping the upper fragment fixed, and bringing the lower one into the same straight line, so that the proper relations between the two may be restored. This is **coaptation or setting.** It is sometimes rendered difficult by splinters of bone preventing the proper adjustment of the two ends, and in all cases *is not to be accomplished by force, but only by careful working by the hand.* Fracture differs from dislocation in the ease with which the bone can be returned to its proper place in fracture, and its difficulty in dislocation. But there is another difference, that, namely, after a fractured bone has been reduced, as soon as the extending force has been withdrawn, the displacement tends to return; and in dislocation, though the reduction is difficult, it is permanent. Therefore in fracture there is the necessity of some means of retaining the bone in position, once the reduction has been effected. This is accomplished by mechanical means—by the use of splints made of wood, pasteboard, or other stiff material, to which the limb is strapped. The splints ought to pass from the joint immediately above the fracture to the joint immediately below, and are usually placed on each side of the limb. The splints are fitted more accurately by the use of pads, and are secured by bandages. So well should they fit and so tightly ought they to be secured, that not the slightest movement can be effected between the opposed ends of the broken bone. Such movement, if permitted, is one of the commonest causes of non-union of fracture. At the same time care must be taken that the bandages do not unduly or irregularly compress the soft parts of the limb or interfere with the circulation of blood in it. The person ought to be laid upon a firm mattress, soft beds being hurtful, and the limb ought to be equally supported on the bed, so that no undue weight is on any part of it. From time to time an examination must be made to see that the broken parts retain their position; and this ought to be done without disturbing the splints or their fastenings. The splints ought, for this purpose, to be kept applied to the limb by straps independently of bandages, so that if the bandages require to be removed the fixture of the splints is not interfered with. (For bandaging, &c., see p. 954.)

As the result of fracture there may be some degree of fever and inflammation. To combat these the patient should first of all get some opening medicine, of which salts, seidlitz, &c., in faot saline medicines, are the best. To the part, if inflamed, cold water cloths may be applied; and to allay pain one-grain doses of opium may be administered at night, but *only to an adult.*

After the fracture has been kept in splints for several weeks there is risk of the joints in the neighbourhood becoming stiff and fixed. To prevent this, as soon as is consistent with the union of the fracture, four, five, or six weeks after it has been received, the bandages and splints should be undone, and the joint exercised gently by the hands. Rubbing the joints, bathing frequently with hot and cold water, will help this. The place of fracture itself should be guarded by small splints placed immediately over it, or by supports of some other kind, such as stiff bandages. An ordinary leather plaster, heated and placed round the seat of fracture, is a simple and efficient means of doing this.

Compound fractures are often very difficult to treat, and are very dangerous kinds besides. If it is the end of the broken bone that made the wound, and if the bone is still protruding, there is often great difficulty in reducing the fracture. When reduced the fracture ought to be so put up that the wound is left free and open, so that it may be properly and frequently dressed. The wound should be carefully washed with water which contains carbolic acid (one part of the acid to thirty of water), and a piece of lint dipped in this solution ought then to be laid over the wound, the lint being covered by gutta-percha tissue and secured by a bandage. The dressing should be renewed every day or second day. There are various complications which may readily arise in connection with compound fractures, but they are of such a character that only qualified surgeons can deal with them, and therefore it is needless discussing them here. A serious complication is the wounding of an important blood-vessel by the ragged end of the bone and great consequent loss of blood. The bleeding may be temporarily arrested by applying over the wound a thick pad and binding it tightly on with a bandage or handkerchief. (See chapter on Accidents and Emergencies.) Amputation is frequently necessary to save life. When a fracture has united crookedly it may to some extent be rectified by a surgical operation.

Fractures of the Skull.

Fractures of the bones of the skull are, as a rule, so difficult of detection and require such skilful treatment that a surgeon's advice and attention are always necessary. A brief reference, therefore, is all that is required here.

The usual places for fractures of the skull are the vault or roof, and the base. The vault is usually broken by a direct blow, the base of the skull indirectly. Thus when a man is struck on the top of the head with a stone or stick, that is, by a sharp concentrated blow, fracture of the vault is likely to occur; but when a man has fallen from a height upon his head, or when his head has been caught between two opposing forces, it is the base that is commonly the seat of fracture. Fracture at the base also occurs by a person falling from a height and landing on his feet or in the sitting posture, the force, being transmitted up the back-bone, causing the break to occur.

The bones of the skull consist of two plates of dense bone, one without and one within, and a layer of spongy bone—the diploe—between. Now a fracture may consist of a crack or fissure, or of a breaking inwards of one or other of these dense plates, or of both together.

In **Fractures of the Vault** the forcing inwards of one or other or both bony plates is the most common form. Thus, there may be simple fracture or fracture with displacement, and as the displacement is almost invariably inwards it is called **fracture with depression.** The broken bone may be depressed in a piece, or it may have been broken into fragments and the fragments driven inwards. The fracture may or may not be accompanied by a wound.

The **symptoms** are not easy to make out. If it is a simple fissure there may be no signs of any moment. When the bone has been depressed, the hollow may be made out by careful examination with the fingers after shaving the part. The hollow will be surrounded by a projecting ridge. Care must be taken not to confound this feeling of a depression with the sensation caused by a mass of blood-clot forming within the scalp, which will yield to firm pressure with the finger. Where a wound exists the forcing inwards of the bone will be more easily made out, and examination with a probe will reveal the mischief more fully. It must be remembered, however, that the inner table may be splintered and depressed and little corresponding injury be present in the outer table.

The **treatment** consists in putting the patient to bed, keeping him lying on his back, quite quiet, applying cold-water cloths to the head, and giving opening medicine. The fall or blow may have brought on unconsciousness, in which case the patient is simply to be kept quiet, and to be made warm by clothing and the application of heat to the feet. If consciousness does not soon return, and if the breathing is slow and laboured, the skin cold, and the pulse weak, a serious condition of the brain is indicated, due, likely, to depression of bone. This can be remedied only by raising the depressed bone, which no one but a surgeon can undertake to perform.

Fracture of the Base of the Skull is usually determined by the kind of injury, by bleeding from the nose and from the ear, and by the oozing from the ear of a clear fluid after bleeding has ceased. This fluid comes from the membranes covering the brain, and is a very sure sign of fracture at the base of the skull. There may be other symptoms present, such as deafness, drawing of the face to one side owing to paralysis of the other, inability to swallow, and other signs due to injury of certain nerves. The eyes also may be completely bloodshot. There is likely to be extreme stupor, quick pulse, hot skin, and maybe delirium.

Treatment consists in perfect quiet and rest, shaving the head, and applying cold-water or iced cloths, giving opening medicine and low diet.

Fracture at the base of the skull is very fatal.

Fractures of the Bones of the Face.

Fracture of the Nasal Bones is frequently produced by blows or falls. The swelling and discoloration are likely to be great, and depression of the bones will usually indicate the fracture, the bridge of the nose being broken down. There may be severe bleeding, and headache is likely to result from the accident.

The **treatment** consists in trying to remedy the depression by the fingers, or by pushing a gum-elastic catheter (see Catheter—MEDICAL AND SURGICAL APPLIANCES) carefully up the nostril and trying to replace the bone from within. If the bleeding is excessive it should be stopped by pushing plugs of oiled lint up the nostril. The swelling and headache are to be met by cold applications, and purgatives of some kind of salts. *Some time after* the injury hot cloths will give more relief than cold applications,

though cold is the proper remedy *immediately on receipt of the injury*, since it tends to arrest bleeding, which heat would only encourage.

Fracture of the Lower Jaw is not uncommon. It also is due to violent blows or falls; a throw from horseback might easily produce it. The break usually occurs towards the front in the neighbourhood of the eye-teeth, a little to the right or left of the middle line. It may be on both sides, so that a portion of the bone, carrying one or two teeth, is entirely separated from the rest, and held in position only by the soft parts.

Signs.—The fracture is usually easily recognized by the unnatural power of movement of the part, the grating (crepitus) when the parts are moved against one another, and the irregularity in the line of the teeth. There are also pain, swelling, and inability to move the jaw. The gums are usually torn and bleeding.

Treatment.—The difficulty is to keep the parts at rest, since that implies moving the jaw as little as possible for from four to six weeks, and therefore interferes with eating and speaking. A special splint has to be made of pasteboard or gutta-percha, the latter being preferred, cut to a particular shape, and moulded to fit the jaw after being softened in boiling water. Fig. 30 shows the shape of the splint; the size should be determined by the jaw to which it is to be applied. The long part (*a*) of the splint is applied along the jaw from one side to the other, while the shorter piece (*b*) doubles down under the chin, and should be long enough to permit of its ends projecting from beneath the chin at each side, the projecting ends being then folded up on either side. The gutta-percha should be first cut and shaped to the proper size, taken in paper, and after being thoroughly softened should be quickly applied so that it may take the accurate form of the jaw without trouble. It ought to be kept in position by a four-tailed bandage made of a yard and a half of cotton cloth about four inches wide. The bandage is torn up lengthwise from each end, so as to leave eight inches in the middle, which has a hole cut in its centre to receive the point of the chin. Two of the tails are then brought up, one on each side of the head, and tied over the top of the head; the other two are tied behind the head. The bone must be kept fixed in this way for from four to six weeks. During that period only soft or liquid food should be given, so that no chewing is required, and speech should, as much as possible, be avoided. If the fracture has been attended with much bruising or swelling large soft poultices should be applied, which will be sufficient to keep the parts in position till the swelling subsides, when the splint may be used.

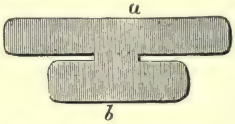


Fig. 30.—Splint for Fracture of the Jaw.

Fractures of the Bones of the Upper Extremity.

Fracture of the Collar-bone (*Clavicle*). This is a very common fracture, the most common, indeed, with one exception—that of the radius, and is most frequently due to indirect violence, such as a fall on the shoulder. It may be caused by direct violence. It is extremely common in children, in whom, however, it does not always break completely through, but takes the form of *green-stick* fracture. The break is usually near the middle of the bone, but sometimes it occurs nearer its outer end, when it may not be so readily recognized because of certain ligaments which pass from the outer end to the acromion and coracoid processes of the scapula (see p. 21) and prevent the usual displacement.

Signs.—When the fracture is complete the weight of the arm carries the shoulder downwards and inwards towards the middle line because of the loss of its main stay, and because of the action of the muscles passing from the chest to the shoulder. As the result of this the skin and tissues over the seat of fracture are stretched, and the *outer end of the inner fragment* is found projecting. This *is not because of its displacement, but because of the falling down of the shoulder*. To the outside of this projection is a hollow. The outer fragment is carried below the level of the inner one, the two ends often riding. The patient is unable to lift the affected arm, and supports it close to the side. Comparison with the sound side will prove the deformity. In children there may be little or no displacement, either because the fracture is not complete or because the bone has been broken straight across and the outer lining is strong enough to support it. By running the finger along the bone the fracture will be found, irregularity being perceived over the spot where the break is, and pain being experienced by the child at that place.

Treatment.—The displacing forces act downwards, forwards, and inwards; the retaining apparatus must therefore act in the opposite

FIRST-AID IN FRACTURED COLLAR-BONE AND FRACTURED FOREARM.

I. This illustration shows the method in use in the Army Medical Department for first-aid in fractured collar-bone. The right-hand side of the plate shows the completed method, the left-hand side shows the arrangement before the application of the sling. A firm pad is thrust up into the armpit of the injured side to press the shoulder upwards and outwards. The arm is brought firmly down over the pad, elbow pressed close to the side, and forearm bent across the body; the pad in the armpit acts then as a fulcrum, by which the shoulder is forced outwards. The shoulder and arm are kept in this position by a triangular bandage, folded as follows: —Bring the point down to the centre of the base and fold lengthways twice. Lay the centre of this bandage over the outside of the upper arm, carry the front end over the chest, carry the back end over the arm, pass it between arm and chest on the upper side of the front part, then down over the front part, then up behind the front part through the loop thus formed. Then carry this end round the back, pulling on it steadily and strongly to draw the arm backwards, and knot off on the opposite side under the arm of the uninjured side. Then put on a sling, but instead of carrying the lower end of the sling up over the injured shoulder, carry it between the side and upper arm and so up to knot off behind.

II. This shows on the left-hand side splints fixed by bandages over a broken forearm, and on the right-hand side the forearm, after the application of splints, supported by a sling. (See p. 994.)

1a.

FIRST-AID IN FRACTURE OF COLLAR-BONE AND FOREARM.

Plate Ia.

I. First-aid treatment of Fractured Collar-bone.

II. First-aid treatment of Fractured Forearm.

directions—upwards, backwards, and outwards. To replace the bone, place the patient in bed on a firm mattress, with a pillow lying lengthways down between the shoulders. Standing behind the person pull the shoulder upwards and backwards and reduction will be effected. As soon as the reducing force is removed the displacement returns. The simplest retaining arrangement is as follows:—a pad of considerable thickness, made of cotton-wool rolled up in a handkerchief, is placed well up into the arm-pit and the arm folded down over it, the pad being retained by a strap over the opposite shoulder; this forces the shoulder *outwards;* the elbow being kept close to the side, the forearm and hand should be laid across the chest, the fingers pointing to the opposite shoulder and reaching well up towards it; a few turns of a roller bandage right round the body keep the elbow at the side and the shoulder well *back;* the elbow should be supported, and the shoulder pushed and kept *upwards*, by a sling tied over the opposite shoulder. (Fig. 31.) If the pad, sling, and bandage are properly adjusted and the arm placed properly across the chest the displacement should disappear, and this tests the accuracy of the adjustments. Union takes place in three weeks or four, in young people even earlier. The bandages should occasionally be examined to see that they do not become loose. Union does not usually occur without some shortening.

Fig. 31.—Treatment of Fractured Collar-bone.

Fractures of the Shoulder-blade (*Scapula*).—The shoulder-blade is so well padded by muscles that little displacement is, as a rule, produced by fracture. The break is usually due to direct violence, such as the passing of a cart-wheel over the back. Movement and grating are best detected by grasping the shoulder and upper part of the bone with one hand and the lower corner of the shoulder-blade with the other and trying to move them on one another, or by placing one hand flat over the bone and moving the arm in various directions.

Treatment.—This fracture requires no setting because, as already explained, the muscles prevent any displacement. Put a thick pad of wool over the shoulder-blade, or mould a gutta-percha shield over it, retain by a firm bandage, and put the arm in a sling.

Fracture of the Point of the Shoulder (*Acromion process*).—This fracture is usually caused by a blow from above. The deformity consists in the absence of the usual roundness of the shoulder. Compare both sides, and note that on the affected side there is a sudden sinking of the extremity of the shoulder. The process can be felt floating in the hollow. When the arm is raised the fragments may be brought into apposition, and grating is felt, the roundness of the shoulder being restored. The person is unable to raise his arm to any extent.

Treatment.—The acromion cannot be accurately adjusted to the shoulder-blade, and, besides, unites only by ligament. The sole treatment, therefore, consists in keeping the arm well supported by a sling for about four weeks. The patient will never be able comfortably to place his hand on the top of his head.

Other fractures of processes of the shoulder-blade are too rare to be noted here.

Fractures of the Arm-bone (*Humerus*).—The humerus is liable to fracture of the upper end, or head and neck of the bone, of the shaft, and of the condyles or lower end.

Fractures of the Upper End of the Arm-bone are generally produced by a fall on the upper part of the arm, when the shoulder comes into violent contact with the ground.

Signs.—The lower fragment is drawn by muscles inwards towards the arm-pit, and slightly upwards, so producing some degree of shortening, the upper fragment being tilted slightly outwards. The hand placed in the arm-pit will be able to detect the sharp edge of the lower piece. The roundness of the shoulder is maintained, but the finger passed over the shoulder comes down the arm only a little way before it reaches a break or hollow. There is pain and loss of function, and the man *keeps his arm close to his side.* When the lower fragment has been pulled down, the two ends will come into contact, and grating will be felt. Unnatural mobility also exists, but this is not so easily proved, because the person keeps the muscles strained to prevent movement.

This fracture is often confounded with dislocation of the shoulder; and it is of extreme importance to distinguish them, since the force required to reduce a dislocation might, if practised on a fracture, lead to very serious results. The following table shows the differences:—

Fracture.	*Dislocation.*
The roundness of the shoulder is maintained, the hollow being *a little way down the arm.*	The roundness of the shoulder is lost, the hollow being *immediately beneath* the point of the shoulder.
There is a foreign body in the arm-pit, which is found to present a sharp ragged edge.	The body in the arm-pit has a round globular head and no sharp edge.
Increased power of movement.	Unnatural fixture, the arm cannot be freely moved.
The arm can be easily pulled down, and then crepitation (grating) is developed.	It is very difficult to pull down the arm, and there is no crepitation.
After reduction, on removing the reducing force the deformity returns.	After reduction, on removing the reducing force the limb remains replaced.
Arm shortened.	Arm rather lengthened.
Arm is held close to the side.	Elbow sticks out a little from the side, and cannot be brought close.
Usually produced by a fall on shoulder, the arm being at the time close to the side.	Usually produced by a fall, the arms being outstretched.

In children this fracture sometimes takes the form of separation of the epiphyses—the ends of the bone which have not yet become united to the shaft. It is very necessary to restore the proper position of the parts, otherwise development of the arm will cease. It occurs in children under ten only. Its signs are the same as those already described.

Treatment.—Bend the elbow, fold the arm across the chest, so that the thumb is directed upwards. Grasp the elbow and pull gently and steadily downwards, counter-extension being made by fixing the shoulder. This reduces the fracture, the deformity disappears, and the normal length of the limb is restored. To retain the limb in position two splints are necessary, one, long and right-angled or L-shaped (Fig. 32), so as to fit the position of the forearm across the chest, being placed on the inside, the other, a short moulded splint, being applied over the shoulder and seat of fracture. The inside splint is made of wood, and should be long enough to reach up into the arm-pit. To prevent pressure on the blood-vessels in the arm-pit, the top of the splint ought to be scooped out. One limb should extend down to the elbow, from which point the other limb comes off at an angle to pass along the forearm and hand. Before applying this splint, the hand and forearm should be bandaged. The splint is next to be carefully padded with cotton-wool, especially at places like the elbow where there are prominences of bone, and held in position, till the other splint is ready, by a few turns of a roller bandage. The outer short splint is made of gutta-percha, pasteboard, or other pliable substance. It is well softened in hot water, and is then placed, also padded, over the seat of fracture, to prevent the tilting outwards of the upper fragment. It should be long enough to project over the shoulder, round which it is to be moulded, and should pass downwards past the fracture to about the middle of the arm. This is immediately secured by one or two straps which bind both inner and outer splints. A roller bandage is then applied from the hand right up to the shoulder in the manner described under BANDAGES; and the forearm is then supported by a sling. It adds greatly to the comfort of the patient if, before the bandages and splints are applied, the arm is washed with soap and water, carefully dried, and then dusted with dusting powder. After not less than three weeks and not more than five, the splints should be removed in order to permit movement of the elbow and shoulder joints to prevent stiffening. The movement is not to be effected by the patient himself, for that would set muscles in action, and that is not desired; but some person must work the joints for a few minutes several times a day. To permit of this, and at the same time support the limb, small gutta-percha splints should be applied over the seat of fracture inside and out. After five or six weeks the patient may be permitted to swing his arm gently backwards and forwards, and gradually to bring it into use. In spite of the utmost care some permanent deformity is not unlikely to occur. The arrangements for this fracture are similar to those shown in Fig. 33, with this exception, that the outer splint should in this case be moulded round the top of the shoulder.

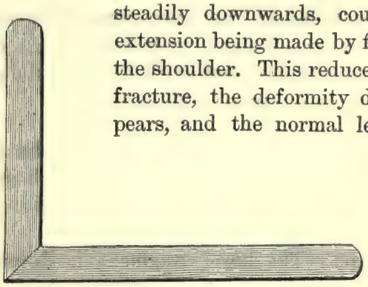


Fig. 32.—Right-angled Splint.

Fracture of the Shaft of the Arm-bone usually occurs below the middle of the bone. Falls on the hand or elbow are frequent causes. The fracture may be across or aslant,

and presents all the usual signs of fracture, unnatural mobility, deformity, loss of function, and crepitation when the ends are brought into contact with one another. The displacement is effected by muscular action drawing the lower fragment to the inner side. Riding is also present, and shortening.

The **Treatment** (Fig. 33) is practically the same as that for fractures of the upper end.

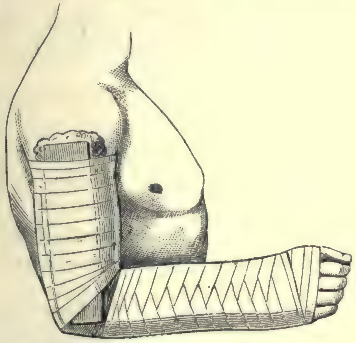


Fig. 33.—Arrangement for Fracture of Upper Arm.

The outer splint, however, need not go over the shoulder, but where the break is in the neighbourhood of the lower end it may be moulded round the elbow.

Fractures of the Lower End of the Arm-bone.—There are various kinds of fracture in this region. In one form there is a break across just above the joint; in another the fracture extends into the joint, the break extending both across the bone and running down the middle into the joint, so as to separate the processes, or condyles, that project on each side, from one another; while in a third form the epiphysis—the end not yet united to the shaft—is separated from the rest of the bone. A fall upon the elbow will readily produce this fracture.

Signs.—Deformity—the bones of the forearm, with the lower fragment, are, by muscles at the back of the arm, pulled upwards behind the upper fragment which projects in front, the two fragments riding on one another. The size of the joint from behind forwards is thus greatly increased and changed in shape, as may be seen by comparison with the arm of the other side. The projection in front is found to have a ragged edge, and the measurement from the top of the shoulder to the end of the arm-bone is less on the injured than on the sound side. On the other hand, the measurement from the knuckle of the middle finger to the end of the lump behind the upper arm is greater than the measurement of the forearm bones on the sound side, because to the forearm bones is added the length of the lower fragment retained in their grasp. Let an assistant hold the upper arm, let the operator place his knee in the elbow, grasp the wrist and pull the forearm round his knee. This easily reduces the fracture, and when it is reduced grating can be felt. As soon as the wrist is let go, the deformity returns. This is a fracture liable to be mistaken for dislocation at the elbow-joint. The differences are shown in the following table:—

Fracture.	*Dislocation.*
Kind of fall—fall on elbow.	Kind of fall—fall on hand, arm being bent
Projection behind of great mass, consisting of olecranon process of ulna grasping condyles of arm-bone.	Projection behind—olecranon alone.
Projection in front—small, broken end of shaft, not pushed deep down into elbow.	Projection in front—articulating end of humerus—condyles—pushed far down.
Motion increased.	Motion diminished.
Crepitation (grating) present on extension.	Crepitation absent.
Length of upper arm shortened.	Length of upper arm natural.
Length of forearm increased.	Length of forearm normal.
Reduction easy and not permanent.	Reduction difficult, but permanent.

Treatment for this fracture is also similar to that described under fractures of upper end of humerus, the outer splint being here moulded round the elbow-joint behind. The prominences of the joint should be carefully padded. The passive movement of the joint should be begun in about three weeks.

Splitting of the Condyles (p. 22) may be easily recognized by causing the elbow to be bent and stuck out behind. Then stand behind the patient and place one thumb on the projection of the humerus on one side, and the other thumb on the condyle of the other side, and press. If the condyles move on one another, splitting has occurred. The treatment is as above; or the joint may be entirely surrounded by a mould.

Fractures of the Forearm occur at the upper end, or at the shaft of radius or ulna (p. 22), or of both together, and at the lower end.

Fracture of the Olecranon (p. 22).—This is the fracture that occurs at the upper end, the olecranon being the process of the ulna that grasps the arm-bone behind, and forms the point of the elbow or "funny-bone." It is usually due to a fall on the elbow.

Signs.—It is easily distinguished. The chief muscle of the back of the arm—the triceps—is attached at its lower end to this process, and consequently when the connection between the ulna and the olecranon is severed the triceps has nothing to oppose it and pulls the point of the elbow up on the back of the upper arm. The point of the elbow is, therefore, gone, and a hollow is in its place. The person can *bend* the arm, but has great pain and inability to *straighten* it. The olecranon can be felt up in its unusual position and can be pushed down.

Treatment is a matter of some difficulty, because of the impossibility of overcoming the action of the muscle and keeping the process down in position; secondly, because union is by ligament and not by bone. The only way would be to keep the arm quite straight by a splint; but this is exceedingly irksome. The patient must make up his mind to get only a moderately satisfactory result, which will leave his arm not so powerful as before. The simplest method of treatment is to fix the arm at an open angle, to mould a splint for the back of the elbow, cutting in it a hole to admit the process, the edges of the hole being carefully rounded. Put this splint on, keeping the olecranon down in position as well as possible by means of the hole, and fix with a starch bandage (see BANDAGES) from the fingers up to the elbow.

Fracture of both Bones of Forearm at the centre of the shafts happens by direct violence. It is easily recognized, all the signs of fracture being easily made out. The bones are displaced towards the middle line of the arm, that is, they approach one another.

When only one bone is broken, the other one acts as a splint and prevents displacement. The way to detect the fracture in this case is to follow the outline of the bones by running the fingers firmly down from the elbow to the wrist. Examine one bone at a time. When the fingers come over the seat of fracture, the bone is felt to yield under the fingers, there is grating, and the patient feels pain.

Treatment.—Whether both bones be broken or only one the treatment is the same. Reduce the fracture by pulling on the wrist while an assistant keeps the upper fragment fixed. Then apply both outside and inside splints as broad as the arm, made of wood, or pasteboard, or similar material, and padded with cotton-wool. The splints should fix the wrist joint, but leave the elbow joint free. When the splints are being applied the hand should be held so that the thumb points directly upwards. Care ought to be taken that when the arm is bent the inside splint does not press hard up into the elbow, as it might compress blood-vessels and do harm. The splints should be secured by three straps, and then by a roller

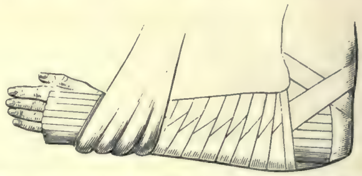


Fig. 34.—Application of Splints, &c., for Fractures of Forearm.

bandage from the points of the fingers up to the elbow (Fig. 34). The risk is that union may take place, not only between the ends of each bone, but also between the bones themselves, so that turning the palm of the hand upwards or downwards is afterwards prevented. To avoid this a pad or ridge of cotton-wool is recommended to be placed down the length of the arm, under the inside splint, to keep the two bones apart. There is danger of pressing too much on the blood-vessels by this, and it is, therefore, better to omit it. After bandaging put the arm in a sling. *No bandaging is here required previous to the application of the splint.* For this fracture splints are readily furnished out of bandboxes and similar material, the thin wood torn from which is cut to the size and shape required, and then steeped in hot water till it can be moulded, several layers thick, to the limb.

Fracture of both Bones close to the Wrist Joint may, from the nature of the deformity, be mistaken for dislocation at the wrist joint, though it must be noticed *that simple dislocation of the wrist joint is extremely rare.* In fracture the wrist bones with the lower fragments of the radius and ulna are shot up either in front of or behind the upper fragments, while in dislocation the wrist bones alone are carried up in front of or behind the forearm. The landmarks are the projecting processes—styloid processes—of the radius and ulna, on the outer and inner side. In fracture these are seen standing out from the sides, and bone can be detected beyond them, the wrist bones being still embraced by them. Next measure the forearm

bones from the point of the elbow downwards to the projecting ends, and compare with the measurements of the opposite side. In fracture the measurement is less than the usual. Measure also from the knuckle of the middle finger to the upper end of the lower fragment. In fracture it is greater than the ordinary measurement from the same point to the lower end of the forearm bones. The other signs of increased movement, grating, &c., are present in fracture.

The **Treatment** is the same as that already described for fractures of the shaft, viz. two straight splints.

Fracture of the Lower End of the Radius (p. 22)—Colles' Fracture.—This is a fracture of very common occurrence. About one-third of the total number of fractures occurring in the body is of this kind. It is specially frequent in old people, and is oftenest caused in them by slipping on the street and falling on the hand, palm downwards, which has been put out to save them. It is a fracture of the radius, which is on the outer or thumb side of the forearm, and occurs about an inch above the wrist joint. It is called Colles' fracture, because it was first described by Dr. Colles of Dublin in 1814. It deserves special notice, not only because of its

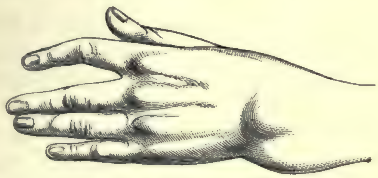


Fig. 35.—Colles' Fracture.

frequency, but also because of its liability to be mistaken for dislocation of the wrist.

Signs.—The deformity is very peculiar (Fig. 35). The radius being broken, the support on the thumb side is removed and the forearm muscles so act on the hand as to pull it down to that side. As a result of this the skin is stretched on the inner side, and the projection—styloid process—of the bone on the inside of the wrist joint is very prominent, the stretching of the skin over it causing the patient to complain of pain there. This must not cause the attention to be diverted from the real place of the injury, which is on the outside. The lower fragment rides obliquely on the upper and produces a lump on the back of the forearm, and this again causes a sudden hollow in front between the hand and forearm. The patient cannot turn his wrist to lay the hand either palm downward or upwards. When the displacement has been reduced crepitation can be made out. The ulna is of usual length, but measurement shows the radius to be shortened.

Treatment.—To reduce the fracture support the forearm below the place of fracture with one hand; with the other grasp the hand of the patient as is done in "shaking hands," and pull the hand from the position of being drawn towards the radial or thumb side towards the ulnar or inside. A considerable force is frequently necessary to do this. The hand is pulled down towards the supporting hand of the operator, which acts as a fulcrum for the movement. As soon as the fracture has been reduced the deformity disappears. The best splint for retaining the bone in its proper position is the "pistol splint," so called from its appearance. It has a long straight part which should reach from the elbow to the wrist, and as broad as

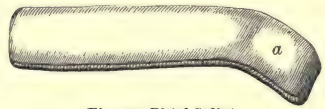


Fig. 36.—Pistol Splint.

the broadest part of the forearm; it has also a part called the handle (*a*, Fig. 36), which should be as long as the distance between the wrist and tips of the fingers, and is directed downwards, forming an angle with the long portion equal to half a right angle. It is usually made of wood. To apply it, bandage the fingers and hand, pad the splint with cotton-wool, and then with a roller bandage fix the *handle of the splint to the back of the hand,* that is, *on the outside,* the hand being held thumb side upwards. When it has been fastened on so, the long portion of the splint is out of line with the forearm, projecting below it. Bring the long portion up to the line of the forearm, applying

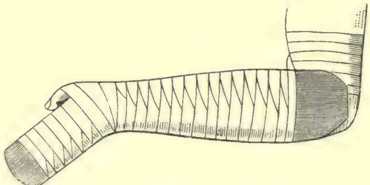


Fig. 37.—The Pistol Splint applied.

it close to the back of the arm. By this movement the handle is made to carry the hand downwards towards the ulnar side, aiding in the setting of the fracture, and retaining the ends of the bone in position. Another splint is then placed inside. It should be moulded out of pasteboard, gutta-percha, or other mouldable material, and should reach from the elbow

to the wrist only. Fix the whole by means of a bandage from the fingers to the elbow. (See Fig. 37.)

The trouble from the wrist joint is very great, owing to the great risk of stiffness resulting. The fracture will mend in a few weeks if properly put up; but it may be months before the wrist regains its function, if it ever thoroughly does so. Therefore in about three weeks in a young, and four in an old, patient, the wrists and joints of the fingers should be moved. Rubbing with liniments will also help to restore the function.

Fractures of the Bones of the Wrist (*Carpus*) may occur from direct violence, such as the passing of a wheel over the hand, but the deformity is not marked owing to the smallness of the bones and their numerous connections. There will be pain, swelling, and on handling the fingers may detect grating (crepitation).

Treatment.—Keep the wrist at rest by binding on the palm side a splint well padded. With the splint on the palm side, cold lotions, hot cloths, &c., may be applied on the back of the hand to keep down inflammation.

Fractures of the Bones of the Palm of the Hand (*Metacarpus*) are not unfrequently due to striking a blow with the closed fist.

The **Signs** are movement of the fragments and grating. Displacement is not so common here, but it may occur, the head of the bone sinking down towards the palm, and a projection being formed on the back of the hand.

The **Treatment** recommended by Sir Astley Cooper consists in causing the patient to grasp a large ball and then binding a roller bandage round the whole.

Fractures of the Bones of the Fingers (*Phalanges*). These bones are often broken, usually with a wound or severe bruising. Sometimes the wounding is so severe that amputation is necessary. Every effort should be made to save a finger; and special pains ought to be taken with the thumb and forefinger.

Treatment.—Apply a thin wooden splint, lightly padded with wool, to the front of the broken finger, and secure with a narrow bandage. In about three weeks begin to move the joints to avoid stiffness of joints becoming permanent. If serious wounds exist the dressings will require to be renewed every two or three days. This should be done, if possible, without moving the splint. A moulded splint of gutta-percha or pasteboard is very comfortable.

Fractures of the Spine.

The spinal column may be broken by indirect or direct violence. A heavy weight, such as a sack of flour, falling on a man's neck and shoulders may break the back some distance down. Again, a man has been known to be sitting on the branch of a tree when it broke and allowed him to fall to the ground in the sitting posture, fracture of the spine high up resulting. These are cases of indirect violence. Direct violence has many instances, a very common one being that of a miner whose back is broken by the fall of a mass of coal or earth as he lay, or was crawling along, face downwards. The break is generally transversely through the bodies and arches of the vertebræ. The accident may be a simple one or very grave. Spinous processes may be broken off merely, or vertebræ twisted round or otherwise displaced, with nothing further of any consequence, recovery taking place with some deformity but nothing worse.

In the majority of cases, however, the spinal cord is seriously injured, and the symptoms vary according to the degree and position of the injury.

Signs.—At first the person suffers from severe nervous shock, which may produce collapse, shown by pallor, coldness, feeble pulse, vomiting. There may be unconsciousness. When the shock passes off pain is complained of at the seat of injury, especially on movement. There is swelling over the painful part, and irregular projections and depressions can be felt. But the important signs depend on the site of the injury.

(1) *When the injury is below the dorsal vertebræ* (p. 20), in the lumbar region, the legs and lower parts of the trunk are motionless and insensible. At first there will be great costiveness; and afterwards the stools will pass without the patient's will or knowledge. Owing to loss of power over the bladder the urine will be *retained*, requiring to be regularly withdrawn by means of an instrument. At a later period, if the urine is not regularly withdrawn, the water constantly dribbles away because of over-distension of the bladder. In a few days the urine will become offensive, smelling strongly of ammonia.

The person may live two or three weeks, or even a month.

(2) *If the fracture be lower down in the back than the second lumbar vertebra* (p. 20) power and sensation may not be lost, and recovery may be

expected to take place. This is because the spinal cord ends at the level of the second lumbar vertebra, and only appendages of it are continued further down the spinal canal.

(3) *If the fracture be higher up*, in the dorsal region, besides the symptoms mentioned under (1), breathing will be imperfect, and may be further impeded by attendant fracture of the ribs. Death is likely to result in about 5 or 6, or at most 10 or 15 days.

(4) *When the injury is still higher*, at the lower part of the neck, palsy of the arms is added, and the breathing is still more laboured. The patient cannot survive beyond a day or two.

(5) *If the injury be above the fourth vertebra of the neck* (p. 20) death will be instantaneous, because respiration is impossible.

When, as in injury below the dorsal vertebræ, the sufferer has survived for several days, or a week or two, there is great trouble owing to the involuntary passing of stools, the difficulty of keeping him clean, and the retaining of the urine. Bed-sores are a continual source of annoyance. They form most commonly over the prominent parts of the hip-bones and over the projecting process—trochanter—on the outer side of the thigh-bone. They begin to show themselves about the fourth, or even as early as the second, day. Their formation may be detected by the white, sodden appearance of the skin, which afterwards becomes brown, then black in the centre, after which the skin comes away in shreds. The sores form with great rapidity and sap the patient's strength.

Treatment.—First of all great care must be taken to guard against moving the spine while the patient is being carried home, undressed, and put to bed. He ought to be carried home on a stretcher of some kind, and kept from rolling about on the stretcher by bundles of clothing, &c. The clothes should be *cut off* to avoid movement; and the person ought to be laid flat on his back on an appropriate bed. The best bed for the purpose would be a water-bed. If a water-bed is not to be obtained then a bed with a bottom of boards, and one or two firm but elastic hair-mattresses is best. Bed-pans and other similar conveniences ought to be at hand, so that moving the patient is not necessary. Mackintosh cloth, covered with a sheet, ought to be under the the patient's hips. Water-pillows, feather-pillows, or pillows of other kinds, covered with oil-silk, are also necessary for equalizing the pressure on different parts of the body, to prevent, as far as possible, the formation of bed-sores. The urine must be drawn off by a catheter (see CATHETER) twice in twenty-four hours. In fact, as soon as the patient has been got to bed the catheter ought to be passed. The bowels may require to be moved by injection. To prevent bed-sores to the utmost extent cleanliness and dryness are absolutely necessary, and avoiding pressure by the use of pillows. When the sores have formed they should be cleaned with carbolic acid lotion (1 of acid to 30 of water). This lotion should also be applied to the sore by cotton-wool, which ought to be covered with gutta-percha cloth, and retained by straps of adhesive plaster. As to diet, easily digested food is necessary, milk, beef-tea, and similar fluid nourishment. It is to be remembered that exhaustion is often extreme, and requires guarding against. Indigestion is liable to afflict the sufferer. This is to be relieved by acid tonics (see APPENDIX OF PRESCRIPTIONS).

Fractures of the Ribs and Breast-bone.

Fracture of the Ribs.—The ribs may be broken directly by a blow, which is apt to drive the fragments inwards to the injury of the lungs. Pressure on the body, as, for instance, that caused by a man being caught and crushed, say between two barrels or between a cart and a wall, is liable to produce fracture round at the back where the rib begins to curve forwards. In such a case there is great risk of fracture on both sides—a very serious accident. It is of importance to learn how the accident occurred in order to learn whether there is likely to be any wounding of the organs of the chest by the fragments. Fractured ribs added to chronic bronchitis or heart-disease are a very dangerous complication. Coughing may be an indirect cause of broken ribs in old people.

Signs.—The person has short, shallow breathing. There is sharp, stabbing pain, increased by movement and rendering coughing or deep inspiration extremely distressing. The person is able to put his finger on the exact spot where the pain is. The pain does not move about from place to place, but is fixed. If the patient complains not of pain *at a spot*, but of pain all over the chest, the chances are against fracture. If the person indicates the seat of pain, with two fingers trace along the outline of the rib, pressing firmly. When the place of fracture is reached the fingers will detect movement and grating, and the pain will be greatly increased by the pressure. If the person be very stout, and especially if the fracture be near the spine, these signs may not be made out. Nevertheless, if, after injury,

there is pain complained of at a particular spot, on breathing, it is to be treated as fracture.

Treatment consists in giving rest to the affected part and preventing movement of the fragment. This is often done by bandaging the whole chest, but such treatment very often too seriously impedes respiration. A better way is to take strips of adhesive plaster long enough to reach from the middle of the back to a little way beyond the breast-bone. Make the patient lean to the uninjured side, and then, beginning behind, apply the plaster, carrying the strips from the spinal column forwards and slightly upwards to the breast-bone. The strips should be so placed in reference to one another that one half covers the strip immediately below. The strips are to be applied in this way till the whole of the injured side is covered by a sort of cuirass of plaster (see Fig. 38).

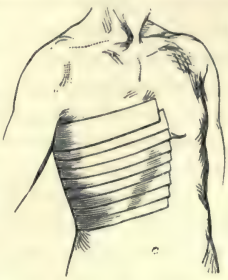


Fig. 38.—Mode of applying Plaster for Fractured Ribs.

For the first twenty-four hours after the accident the person should be propped up in bed in the sitting posture to relieve the breathlessness and feeling of suffocation. If the distress and pain are very great opiates may be necessary, and sometimes, in very exaggerated cases of this kind, bleeding is called for; but recourse should not be had to such remedies without the advice of a surgeon. In the case of an adult ten to twenty grains of chloral hydrate, to relieve pain and induce sleep, is the utmost that ought to be given by inexperienced persons.

Fracture of the Breast-bone (*Sternum*).—The signs of this fracture are practically the same as those of fractured ribs, and the treatment is also similar.

Fractures of the Bones of the Lower Extremity.

Fractures of the Hip-Bones (*Pelvis*) can be produced only by very great violence, and there is, therefore, great probability that other serious injuries will attend its occurrence. The cavity of the pelvis, as has been already explained (see page 22), contains and protects most important organs, which the great violence necessary to fracture the pelvic walls will be very likely to injure. The usual cases of the accident are of miners, upon whom a mass of coal has fallen. By pressing with one hand on either side of the hip grating may be produced. The person will, of course, be unable to sit or stand.

Treatment.—Keep the patient absolutely at rest in bed on a firm mattress or water-bed. A broad belt passed round the hip and firmly fastened will afford great relief. Then it may be necessary to withdraw the urine by means of an instrument, as the bladder may be paralysed. The person ought to be kept clean and dry, and the pressure on the hips relieved as much as possible by pillows, &c., in order to prevent the formation of bed-sores.

Fractures of the Thigh (*Femur*).—Fig. 39 shows a diagram of the femur, in which 1 marks the head of the bone, below which is the neck which unites the head and shaft; 2 and 3 are the prominences called great (2) and small (3) trochanters, of which the great trochanter is on the outside, and can be felt under the skin; A indicates the shaft; and at the lower end are seen the projections or condyles just above the surface for union with the bones of the leg. When the bone is in position in its socket, it is secured there by ligaments which completely surround the head, and form a capsule attached right round the neck of the bone. Now a fracture of the neck of the bone may occur either within the capsule, in which case it is called intracapsular, or without the capsule, when it is called extracapsular. In both cases the result is to separate the head from the shaft of the bone; and the signs are practically the same in both.

Fig. 39.—The Thigh-bone.

Fracture of the Neck of the Thigh-bone occurs usually in old people, and specially in old women. Its frequent occurrence in the aged is determined by changes occurring in the bone by which it is weakened and its resistance diminished. Wasting occurs, causing the neck of the bone to shorten, and the head to sink down towards the shaft. The wasting process is accompanied by an excessive amount of spongy bone substance and a diminished quantity of dense bone, the spaces in the bony tissue being also larger and filled with oil. The bone is consequently much less strong and less liable to bear a force suddenly exerted. Any sudden strain thrown upon it is, therefore, liable to cause it to

snap through the neck. It is just owing to sudden rather than severe strains that the bone most frequently gives way. A trip on a carpet producing a stumble, not even a fall, missing a step, &c., have been known to produce it, while it is frequently due to a fall on a curb-stone.

Signs.—The signs are: (1) Loss of power in the limb; (2) Deformity; (3) Grating—crepitation; (4) Swelling and pain; and (5) Unnatural power of motion.

(1.) The loss of power is immediate, so that the person cannot rise; or if he succeeds in rising, it is only to fall again.

(2.) The deformity is characteristic. It consists in (*a*) a shortening, and (*b*) a turning *outwards*, of the limb (see Fig. 40). The shortening, which usually amounts to between 1 and 2 inches,

Fig. 40.—Fracture of the Neck of the Thigh-bone, showing shortening and turning outwards of the Leg and Foot.

is due to the pulling upwards of the lower fragment by the muscles attached to the great trochanter; and the turning outwards is caused by the weight of the foot. At the same time there is a greater fulness than usual of the groin, an unnatural prominence of the groin, the result of the new position of the lower fragment and of the projection of the broken neck of the thigh-bone. The deformity may not arise immediately on receipt of the accident. The fall may have caused a temporary paralysis of the muscles, and accordingly the displacement cannot be effected till they have recovered. It may be that the ends of the broken bone have become locked, so as to prevent immediate displacement. The displacement may not occur for even a day or two, but suddenly some movement will release the locked fragments, and the deformity appears. It may also come on slowly, as the muscles recover from their paralysed condition.

(3.) The grating or crepitation is produced by pulling on the limb till it comes down to its normal condition, when the two ends of the bone can be brought together. To effect this an assistant should place one hand over the back of the foot and one hand under the heel, and pull slowly and steadily downwards. The person operating should fix the hips with both hands. By applying extension and counter-extension (p. 37) in this way the fracture is easily reduced, and then crepitation is developed by turning the foot up into its proper position. If the limb be now let go the deformity returns at once.

Care must be taken not to mistake this fracture for dislocation at the hip-joint, or for chronic rheumatic inflammation of the joint. In dislocation of the hip there is generally shortening, *but, instead of the foot being turned out, it is, as a rule, turned in.* In a certain kind of dislocation, however, it is turned out, though in this case the limb is lengthened instead of shortened. Then in dislocation there is no crepitation, and the reduction is extremely difficult, requiring considerable force and manipulative skill; while in fracture the reduction is easy. Again, in dislocation the bone, when returned to its socket, remains there, in fracture the deformity returns as soon as the extending force is removed. Lastly, in dislocation there is unnatural fixture of the limb, in fracture, unnatural power of movement.

A person afflicted with chronic rheumatic inflammation of the hip-joint may, after a fall, present features resembling fracture, namely, shortening and turning outwards of the limb. Great pain and swelling will also be present, and there will be loss of power. It will be found, however, that crepitation cannot be produced, neither can the limb be restored to its usual length by extension. Time and rest, with the limb in the position described below, and the application of hot fomentations to the hip, will eventually solve the difficulty. The history of the case will often help to a true decision. If the person has, long before the accident, suffered from pain and stiffness in the hip-joint, increased by wet weather, it is likely to be the rheumatic affection, and not fracture. The doubt can be cleared away at once, however, by an examination of the patient under chloroform. Under any circumstances cases

presenting so much difficulty should always be handed over to a qualified doctor's care.

It has been noted (p. 48) that this fracture is specially liable to occur in old women; and its danger arises from this cause. The shock often kills, but, besides, lying in bed for any considerable time readily brings on congestion of the lungs in old people, and exhaustion is apt to carry the patient off. Then, in old people, such fractures never unite by bone, union by ligament only resulting, and often union does not occur at all.

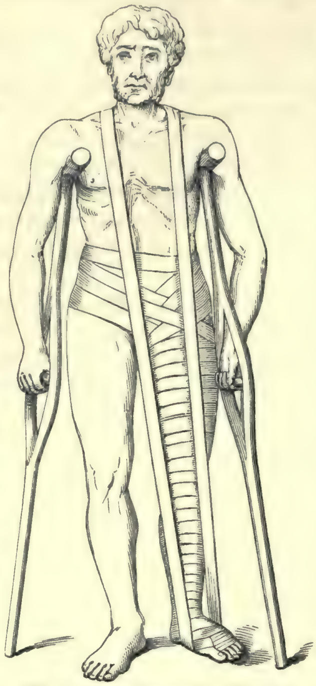


Fig. 41.—Mode of Support for Fractured Thigh in old persons.

The **Treatment** of this fracture, therefore, depends on whether the patient is old and feeble or young and healthy.

When the person is old he should be put on a firm mattress, with a heavy sand-bag on each side of the limb to keep it at rest and in position, and with a bag of sand or shot fastened to the foot, as described under HIP-JOINT DISEASE, and hanging over a pulley at the foot of the bed. This keeps the limb straight, and keeps up continuous extension. After a fortnight the person may get up and sit in a high chair, and may, after a little time, begin to move about with the aid of crutches, the limb being supported by a sling from the neck. (Fig. 41.) Another method of treatment, valuable because of its aid in warding off congestion of the lungs, is by the doubly-inclined plane. Two boards are united by hinges so that they may either be stretched out flat or raised to form a double incline, the top of which is at the hinge. (Fig. 42.) The plane is fixed at the end near the body of the patient to a bed-piece, the sides of which are provided with notches, by means of which the lower end is fixed. The slope of the plane is regulated by the notch into which the lower end is placed. The apparatus is laid on a firm mattress, and is well cushioned, and the patient is so placed that the upper board reaches to the prominences of the hip-bones that form the seat. The leg should be carefully bandaged from the toes to the groin, and two splints made of pasteboard or gutta percha softened by heat are strapped to the thigh on the outer and inner sides from the groin to the knee. The limb is then laid over the double-inclined plane, raised to the angle most comfortable to the person, the hinge of the apparatus being directly under the knee. To the end of the lower board a foot-piece is attached to which the patient's foot is strapped, while holes are bored at intervals along the splint to admit of tapes passing through to secure the limb. A roller-bandage may be passed round both splint and limb. The action of the splint is aided by the patient being propped up slightly with pillows. The Macintyre splint is one made on this plan, with appropriate hinges and screws.

When, however, the person is young and healthy, efforts ought always to be made to secure bony union. This is done by continuous *extension* and *counter-extension* (p. 37) practised by means of Liston's long splint. It is a deal board of slightly greater breadth than the limb for which it is used. It should be long enough to reach from below the arm-pit to 4 or 5 inches beyond the foot. Two holes are pierced at its upper end, and two deep notches are cut out at the lower end. (See Fig. 43.) The limb having been washed, carefully dried and dusted, a piece of broad roller bandage twice as long as the patient is taken, and the centre of it placed across the sole of the foot like a stirrup, the ends passing up the leg, one on each side. A roller bandage is to be then applied to the foot and leg (see BANDAGES) nearly up to the knee, fixing the first bandage on each side. When the knee has been reached the two ends of the side bandage ought to be *folded back down the sides*

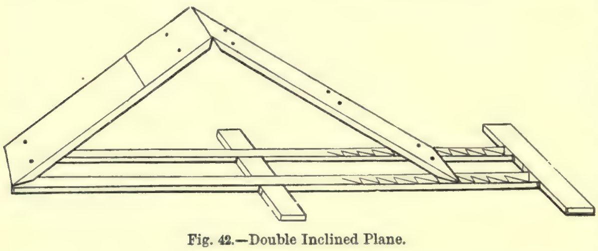


Fig. 42.—Double Inclined Plane.

of the leg, so that the ends hang free beyond the foot, the roller being then carried back from the knee to fix the side bandage a second time. Thus a broad strip of bandage has been firmly secured to each side of the leg, the ends hanging beyond the foot. The splint is now to be padded. This is best done by taking a thick sheet and rolling it round and round the splint, a part being left free to encircle the limb and splint when the splint has been applied. The splint is now placed along the leg on the outside, the free part of the sheet being carried under the leg and left ready to be tied up when required. The two free ends of the bandage that has been secured to the leg are now to be taken and fastened tightly through the notches at the lower end of the splint, so that the foot is securely fixed to the lower end of the splint. The next thing required is a band for counter-extension, called the **perineal band.** A large handkerchief would suit, but the best thing is a special pad made of strong linen in the shape of a bag about one foot and a half long and about 1 inch wide. It should be stuffed with wool, and covered with oiled silk at the place where it comes in contact with the skin. It should have strong linen ends of sufficient length for the purpose to be explained. The pad is placed between the legs so that the centre of it catches on the portion of the hip-bone between the legs. One end passes up over the buttocks behind, the other passes in front. The ends are then taken and one passed through one hole in the upper end of the splint, and the other through the other hole in the same end. All is now ready to be secured. Previous to tightening up the apparatus pad with wool any part not sufficiently protected by the splint-sheet. Now let an assistant take the foot (one hand over the back, one hand supporting the heel), grasping the lower end of the splint at the same time, and make steady extension till the deformity has disappeared and the limb is of the same length as its fellow, which ought to be brought alongside for comparison. At the same time the operator ought to be making counter-extension by steadily pulling the ends of the perineal band through the holes. When the limb has been pulled down sufficiently—and it is best to draw it down even a little farther than its natural length, say ½ to 1 inch more, to prevent shortening—it is secured by tying the ends of the perineal band tightly over the holes through which they pass. The splint-sheet is then brought up on the inside of the leg, folded over, and stitched or laced over the splint. A broad bandage should fasten the upper end of the splint to the body.

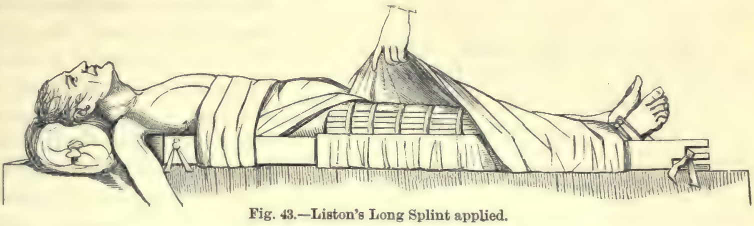


Fig. 43.—Liston's Long Splint applied.

Fig. 43 shows the splint applied, in which also short splints are represented as applied in the fracture next described.

It will take probably six weeks before the splint can be removed. During this period pains must be taken to support the patient's strength with nourishing, easily digested food, and to prevent bed-sores forming, especially in people advanced in years.

After the removal of the splint the limb should be put up in a starch or plaster of Paris bandage (see BANDAGES), and the patient may then be allowed to go about on crutches. Some support to the bone will be required for two or three months.

Fracture of the Shaft of the Thigh-bone is attended with marked symptoms.

Symptoms.—The deformity is caused by the lower fragment being pulled upwards behind, and generally a little to the inner side, of the upper. Occasionally the upper fragment projects forwards. There is loss of power, turning of the foot outwards, shortening of the limb, unnatural mobility, grating when the fracture is reduced, swelling, and pain.

The **Treatment** required is the same as that prescribed for fracture of the bone at the neck, the long splint, which is adapted specially for this kind of fracture. The directions given there should be carried out, with this addition, that directly over the seat of fracture short splints ought to be applied. They are shown applied in Fig. 43. They may be made of several layers of pasteboard or gutta-percha softened in hot water, and should extend a little way above and below the fractured place, being secured by straps of bandage. The long splint is put on outside of them.

After recovery some degree of permanent

shortening is to be expected. It will be many months before anything like natural movement is restored to the joints. To help this, friction, movement by the hands, &c., must be diligently employed.

Fracture of the Lower End of the Thigh-bone is very serious from its nearness to the knee-joint; and as it is frequently the result of direct violence the joint is liable to inflammation.

Signs.—The recognition of the nature of the accident is easy—mobility, grating, shortening, loss of function, swelling—all are present. The lower portion of the thigh is greatly disfigured, because the lower fragment is drawn up behind and to the inside of the upper one.

Treatment.—Put the limb up in the long splint, as directed for fractures of the upper end of the bone, and place short splints in front of and behind the joint, with a pad of wool in the hollow behind the joint. Sometimes this fails to keep the bones in position. In such a case the doubly-inclined plane must be used, as described under FRACTURE OF THE UPPER END OF THE THIGH-BONE (p. 50). A bag of ice or hot fomentations may be required to keep down inflammation of the joint.

Fractures of the Knee-pan (*Patella*).—The knee-pan may be broken across or in its length, or it may be broken to pieces—comminuted. It is frequently broken by muscular contraction. A person slips, or is in danger of falling from missing a step going down-stairs, and makes a sudden strong effort at recovery. The straight muscle in front of the thigh is suddenly contracted, and so the knee-pan to which it is attached snaps through. It may be caused by a blow or fall on the knee.

Signs.—After the sudden snap or the blow the person is unable to straighten his leg, and cannot support his weight on the affected limb. On examination the bone is found in pieces, and a finger may be inserted into the crack between the fragments.

From the difficulty of keeping the parts in apposition this bone unites by ligament only, and the amount of separation between the two fragments depends on the treatment. One to two months are required for satisfactory union.

The **Treatment** aims (1) at relaxing the muscles that would tend to drag apart the fragments, and (2) at keeping the parts in close apposition. This is effected partly by position and partly by mechanical means. (1) The patient is placed in a half-sitting position, and the injured limb is straightened and raised at the heel. (2) For maintaining the bones in apposition a variety of methods have been suggested. A straight, well-padded splint may be put on behind, having two hooks projecting backwards, one a little way above the joint, the other a little way below. The leg is bandaged to the splint from the toes upwards till the lower hook is reached. The bandage is caught on it, and then carried upwards and across the front of the leg above the upper fragment, curving downwards to reach the lower hook again. The same bandage is then caught round the upper hook, and carried downwards round the lower fragment, curving upwards thereafter, to be again fastened to the upper hook. Thus a figure-of-8 movement of the bandage is made, the result of which is to draw the fragments together. Or, the leg having been bandaged from the toes, a short strap of bandage may be placed on each side of the leg, at the knee-joint, secured by two handkerchiefs, one

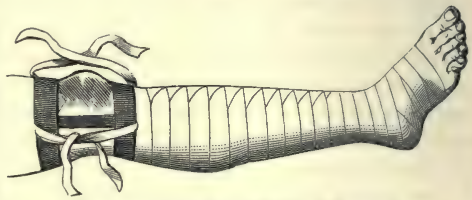
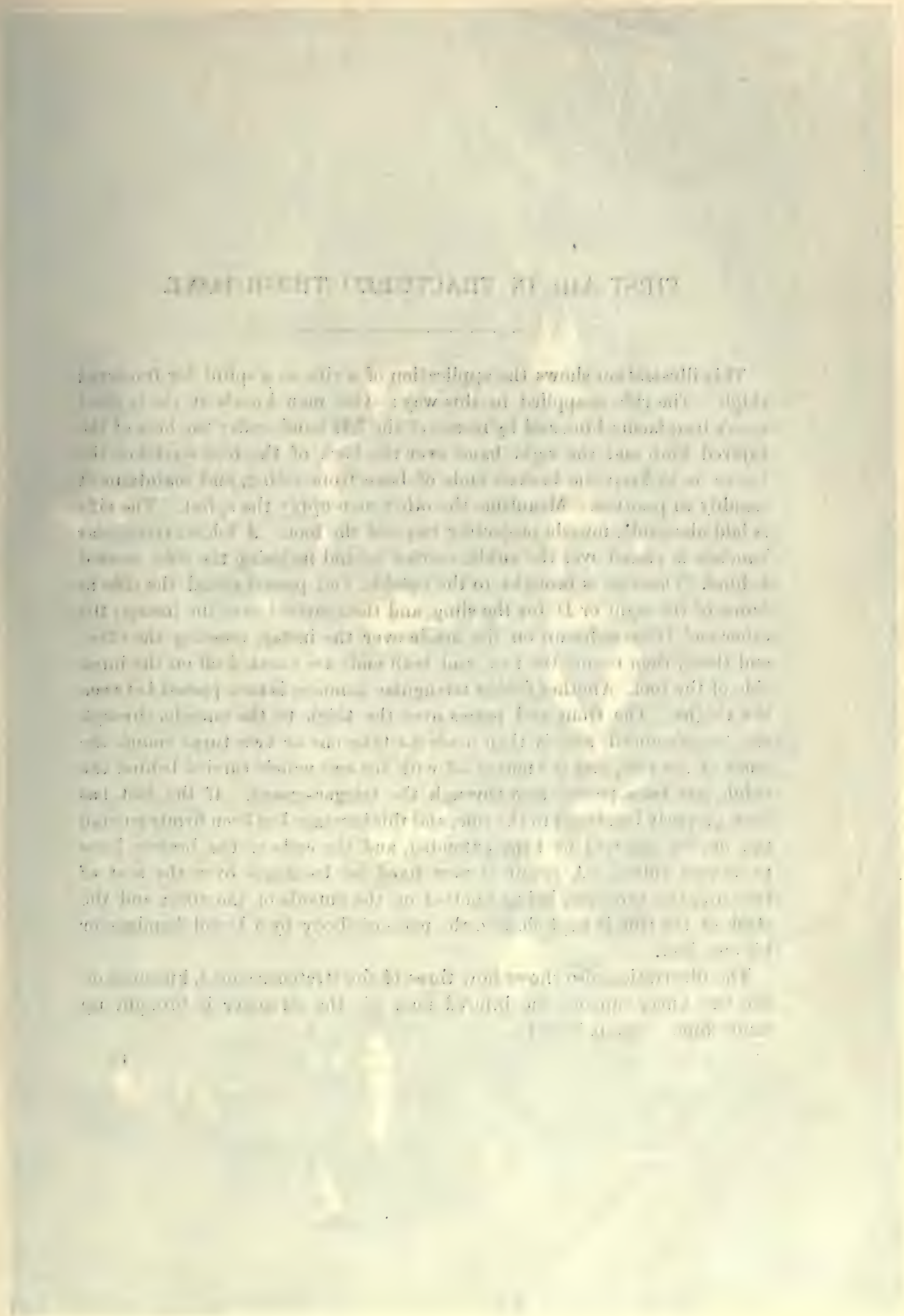


Fig. 44.—Arrangements for Fractured Knee-pan.

tied tightly above the joint, the other tied tightly below. The two handkerchiefs are then pulled together, and the fragments brought together by drawing on the ends of the side strap and tying them. Fig. 44 shows how this method may be applied. An American method is to fix a long strip of sticking-plaster, 2½ inches wide, in front of the limb from the upper portion of the thigh to the middle of the leg, leaving at the knee a free loop. A bandage is applied above and below the knee to fasten the strip. A small stick 6 or 8 inches in length is put through the loop over the knee, and the plaster twisted until the fragments are brought close.

The apparatus should be kept applied for thirty-five to forty days, and afterwards the knee supported by a knee-cap. The knee will never be so strong and useful as before, and some lameness, greater or less according to the closeness of the union, is sure to result.

Fractures of the Leg (*Tibia and Fibula*) are very common, and may be caused by direct violence, but are often produced indirectly, as by jumping from a height. One bone may be broken alone, but fracture of both bones is more



APPLICATION OF A RIFLE AS A SPLINT.

FIRST-AID IN FRACTURED THIGH-BONE.

This illustration shows the application of a rifle as a splint for fractured thigh. The rifle is applied in this way:—One man kneels at the injured man's feet, facing him, and by means of the left hand under the heel of the injured limb and the right hand over the back of the foot stretches the leg so as to keep the broken ends of bone from riding, and maintains it steadily in position. Meantime the other men apply the splint. The rifle is laid alongside, muzzle projecting beyond the foot. A folded triangular bandage is placed over the ankle, carried behind inclosing the rifle, crossed behind. One end is brought to the outside, and passed round the rifle in front of the sight or D. for the sling, and then carried over the instep; the other end is brought up on the inside over the instep, crossing the other end there, then round the foot, and both ends are knotted off on the inner side of the foot. Another folded triangular bandage is now passed between the thighs. The front end passes over the thigh to the outside, through the trigger-guard, and is then made to take one or two turns round the stock of the rifle, and is knotted off with the end which, carried behind the thigh, has been passed also through the trigger-guard. If the foot has been properly bandaged to the rifle, and this bandage has been firmly enough put on, the leg will be kept extended, and the ends of the broken bone prevented riding. A splint is now fixed by bandages over the seat of fracture, the bandages being knotted on the outside of the rifle; and the stock of the rifle is kept close to the patient's body by a broad bandage or his own belt.

The illustration also shows how three of the stretcher squad, kneeling on the left knee, support the injured man till the stretcher is brought up under him. (See p. 1040.)

FIRST-AID IN FRACTURED THIGH-BONE.

Plate Ib.

APPLICATION OF A RIFLE AS A SPLINT.

frequent. The special place is about the lower third of the tibia and higher up in the fibula.

Signs.—If one bone only has been broken there may be little displacement, the other bone acting as a splint. To detect the fracture pass the fingers down each bone from the knee to the ankle. When the broken part is reached the fingers sink down, the patient cries out, and grating is felt. The person is unable to support himself on the injured limb. There will be shortening and overlapping of the bones when both bones are broken, rarely when only one.

Treatment.—Bandage the leg and foot. Place straight well-padded splints, one on each side of the leg, an assistant meanwhile pulling gently but firmly with one hand over the back of the foot, and the other supporting the heel, to keep the bones in position; and bandage the splints and limb together. The splints can be easily made of pasteboard or light wood, such as can be obtained from a bandbox.

Pott's Fracture of the Leg.—This is a fracture of the clasp-bone low down in the neighbourhood of the ankle-joint, associated with partial dislocation of the foot outwards. It is produced by jumping down on the side of the foot. The appearance of the foot is characteristic (see Fig. 45). That the outer bone is broken may be detected by passing the fingers firmly along it down to the joint.

Fig. 45.—Pott's Fracture of the Leg.

Treatment.—This requires a splint with a foot-piece besides a straight splint. The foot and leg are first bandaged. A straight splint, padded, is then put on the outside of the limb. For the inside a splint is required that has a portion projecting upwards, and hollowed out so as to receive the side of the foot and great toe. This can be made on the spot out of some material capable of being cut to the shape required, and then softened and moulded. Bandage splints and limb together. Care must be taken that the foot is at right angles to the leg. It is to keep the foot in this position that the splint with foot-piece is used. *In all cases of fracture of the leg, the foot should be maintained in such a position that the great toe is in a line with the inner edge of the knee-pan.*

In many cases of fracture in the neighbourhood of the ankle-joint there is great difficulty in keeping the fragments of bone in position. If they won't keep in place with the leg straight, then turn the person on his side and bend the limb. Use a straight splint, extending on the inside of the leg from 4 inches above the

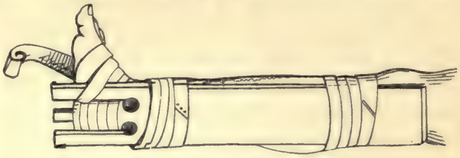


Fig. 46.—Splint for Fracture of the Leg: side view.

knee to 3 inches beyond the foot with two notches at the lower end (Fig. 46). Pad this with a sheet folded double opposite the ankle, or with a pillow made of cotton-wool to suit the splint, and 2 or 3 inches thicker at the lower than at the upper end. A bandage is to

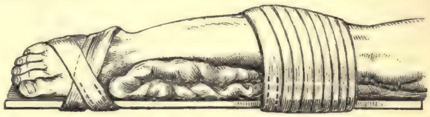


Fig. 47.—Arrangement for Fracture of the Leg.

be then applied so that the foot is bent inwards over the thicker portion of the pad, which should rest against the internal malleolus, the process that projects inwards just above the ankle-joint. Fig. 47 shows the leg in the proper position; and Fig. 46 gives a side view of the same arrangement. The splints ought to be removed after four or five weeks, and movements of the joints practised to avoid stiffening. For several weeks longer support ought to be given to the limb by plaster or bandage or laced boot.

Compound Fractures of the Leg are of frequent occurrence, because the thinness of the muscular covering easily permits the ragged ends of the bone to burst through the tissues. When the bones are projecting they are to be returned as carefully as possible, not by force but by manipulation. The wound is to be washed with a lotion made of one part carbolic acid and twenty parts of water. It is to be covered with a piece of lint soaked in this solution, the lint being kept moist by oiled silk laid over it. In putting up the leg a little window ought to be cut out of the bandages, through which the wound may be dressed. The permanent apparatus ought not to be put on till all serious bleeding has ceased or been stopped. See under ACCIDENTS.

Fractures of the Bones of the Foot are commonly caused by the foot being crushed by heavy weights. There is usually serious mis-

chief, which may necessitate amputation. Sometimes the projecting process of bone that forms the prominence of the heel is broken off, and pulled upwards by the muscles attached to it. Its altered position can be readily perceived.

Treatment.—The foot should be placed at rest on a pillow, and ice or hot cloths used to subdue any threatened inflammation. The best position for relaxing the muscles at the back is with the knee bent and the foot extended as much as possible. This extension of the foot may be effected by a splint passing *down the front of the leg* and pressing on the back of the foot to keep it far down, and the heel consequently high up. Other splints of easily softened material can be moulded to suit the occasion.

It will probably be months before the proper use of the foot is restored. Till then crutches will be necessary.

INJURIES OF JOINTS.

Dislocation.

General Considerations.—A dislocation is the forcible separation of the surfaces of two or more bones forming a joint—the more or less complete displacement from one another of the articulating surfaces of bones.

Its **causes** are Predisposing and Exciting.

Predisposing Causes.—The muscles and tendons are very important agents in keeping the bones together. Anything which weakens or relaxes them will cause liability to dislocation, such as constitutional weakness and relaxation owing to previous disease, dropsy of the joint, for example.

The **Exciting Causes** are—(1) External violence and (2) Muscular contraction. (1) The violence may be applied directly, as when a person falls on the shoulder and displaces the humerus; or indirectly, as when the person falls, not on the shoulder, but on the hand, which has been stretched out to save the person. In the latter case the force acts on the shoulder-joint by means of the leverage supplied by the arm. (2) Muscular contraction during trials of strength, wrestling, or during fits, may cause displacement. The jaw is generally dislocated by muscular action.

Kinds.—Dislocations are *simple* when there is no further injury than the separation of the opposed surfaces of bone, and *compound* when a wound leads into the joint. They are *complete* when no parts of the articulating surfaces of the two bones remain in contact with one another, and *partial* when some portions of the opposed surfaces are in contact, but not the proper parts. Again, according to their period or cause of production, dislocations are said to be *congenital*, that is, born with the child, *pathological*, when the dislocation is due to disease, and *accidental or traumatic*, when force is the agent.

Results.—Besides the bones being forcibly removed from their natural position, a considerable amount of injury is done to the surrounding parts. The ligaments of the joint are torn; muscles are stretched and often torn also; nerves are frequently compressed, causing severe pain at the time of the accident and paralysis afterwards. Blood-vessels are seldom seriously hurt unless in complicated cases, though they too may be compressed and the circulation in the part interfered with. When the bones are restored to their proper position all these breaches are in time repaired; even paralysed nerves may regain their power. But when no reduction has taken place, and the bone has been left in its unusual position, it proceeds to accommodate itself to the new situation. By constantly playing and moving in the unusual place it gradually forms there a new joint. The bone on which it moves gets hollowed out to fit it, and even becomes lined with a substance like gristle. Bands of adhesion are formed to secure the bone, and a joint capsule by and by surrounds the joint, while the old cavity gets filled up with deposited matter. The result of this reparative process is that after the lapse of a certain time from the date of the accident it would be rash and dangerous to attempt to restore the bone to its old socket. It is not merely on account of the fibrous adhesions and capsules that have been formed, but because blood-vessels and nerves may be implicated in the changes that have occurred since the dislocation. Sometimes, especially in the case of small bones, bony union, instead of the formation of a new joint, takes place. At what time it becomes unsafe to reduce an old dislocation it is difficult to say. Sir Astley Cooper said that the thigh could not be reduced after eight weeks, and the arm after three months. But a shoulder displacement has been reduced more than a year after the injury, and without chloroform. In St. George's Hospital Reports two cases are related, one of reduction of dislocation of the shoulder on the one hundred and seventy-fifth day, and the other a reduction of dislocation of the wrist six years after the accident. The possibility or impossibility of reducing an old dislocation depends very much on the patient. If

he is an old feeble man the changes that have been referred to are likely to occur slowly and imperfectly, and adhesions in the new unnatural position are probably correspondingly few and feeble; while if the person be young and vigorous, and especially if inflammation has occurred, the new connections are probably strong, and quickly developed.

Signs.—(1) *Deformity*, (2) *Sudden loss of function*—motion, (3) *Change of length* of the limb, (4) *Change in the relationship of processes*, (5) *Pain, swelling*, and *discoloration*.

(1) The *deformity* is to be ascertained by comparison with the sound side of the body, and care must be taken that distortion, supposed to be the result of dislocation, is not swelling or due to previous injury or disease. The latter is to be learned from the patient himself. The distortion is the effect of the unnatural position of the limb, and generally consists of a prominence at one place and a hollow at another.

(2) *Loss of Function.*—The person cannot move the limb at the joint involved. Inability to move a joint is often present because great pain is produced by the effort, and therefore the patient keeps his muscles tense, so that movement cannot be effected. In dislocation, however, there is actual inability to move the part because the bones have lost their relations to one another, and the muscles cannot act upon the bones in the proper direction. Further, there is unnatural fixture of the bones even to a person, other than the patient, attempting to move them, and even after the patient has been chloroformed and the muscles relaxed.

(3) *Change of Length.*—In all dislocations with one exception the limb is shortened. The exception is the case of dislocation of the thigh-bone forward on the front of the hip—strictly speaking on the obturator foramen (see p. 22). In this case the limb is lengthened.

(4) *Change in the Relationship of Bony Processes* is one of the most reliable signs. For instance, in dislocation at the shoulder-joint, the head of the arm-bone loses its relation to the acromion process of the shoulder-blade, a hollow existing beneath the point of the shoulder where the head of the bone ought to be, in dislocation of the elbow-joint the olecranon process—point of the elbow—and the condyles or projecting processes on each side of the lower end of the arm bone, are severed from their connection. Sometimes, owing to swelling, considerable difficulty is experienced in detecting this sign.

Signs that Distinguish between Fracture and Dislocation.—Distinctions have already been noted between dislocation and fracture at special places. The following general differences are to be noted.

(1) Movement—in fracture the movement is increased, in dislocation diminished.

(2) Presence in fracture of crepitation or grating, when the ends of the broken bone are rubbed against one another. In dislocation there is no true crepitation. A slight crackling or rubbing may exist in dislocation, though it is not developed for a day or two after the accident.

(3) The bony processes have in dislocation lost their relationship; in fracture it is not so, the bony processes of the lower fragment being still in the grasp of the connected bone.

(4) In fracture the deformity is easily removed, but returns on extension being removed; in dislocation reduction is difficult but permanent, the bone returning to its own place usually with a snap.

It is frequently difficult even for experienced surgeons to determine whether the accident is of the nature of a fracture or a dislocation. When it is impossible to decide, the rule is to treat it as a fracture.

Treatment.—The object of treatment is to restore the bone to its natural position. The action of the muscles opposes this object, the tendons also, and sometimes the torn ligaments by being caught round the head of the bone. Not only does the natural tension of the muscles oppose the reduction, but the patient unavoidably increases the force. This difficulty can be overcome by chloroform. It can, however, be administered only by a medical man. There are other means at the disposal of those unqualified to give chloroform. A hot bath, for instance, relaxes the muscles. A simple method is to attempt reduction *before the person has recovered the shock of the accident*, while the muscles are still relaxed; or, if that period has passed, the same result may be partially obtained by suddenly, by a shout or quick exclamation, diverting the patient's attention. In order to draw the bone down from its new position to the place of its socket **extension** is necessary. To effect this the upper bone containing the socket is fixed by an assistant, who, by this means, provides **counter extension.** The displaced bone is then pulled continuously and steadily downwards, till it is brought into such a position that the muscles may set it. At the same time the hands, knee, or foot of the operator may act upon the bone so as to aid in its proper adjustment. This is called **coaptation.**

The extension should be performed in the line of the opposing muscles. Extension may be performed by hand, or by various mechanical contrivances, especially pulleys, while the counter-extension may also be by hand, or by means of bandages passed round the body of the person and fixed to a staple in a wall. A more recent method of reduction is by manipulation. It is specially serviceable in dislocation at the hip-joint, in which great force is required to overcome the resistance of the muscles. In the method by manipulation no force is employed, but the limb is caused to execute certain movements by the hand alone by which the head of the bone is induced to slip back into the joint, the resistance of the muscles not being called forth by the movements. This will be described in discussing the treatment of special dislocations. After reduction the joint ought to be kept at rest for some time to permit of the healing of the torn ligaments, and to avoid the risk of inflammation. Should inflammation be feared, with perfect rest the use of warm fomentations may be conjoined. The application of cold cloths or cloths wrung out of iced water will often give even greater relief. After all danger of this kind has passed away the joint will remain weak for some time. This is to be gradually remedied by gentle movement, made at first by hand then by the muscles of the part, by the use of the hot and cold douche alternately, and by friction with some liniment—soap and opium liniment. Restoration of function by this means is attempted soon enough a fortnight after the accident. For a considerable time, even months, afterwards, the joint must never be placed in a position that would strain its ligaments, since a second dislocation would very readily follow a first.

Fracture is a very serious and dangerous complication of dislocation.

When a wound communicates with the joint from which the bone has been dislocated, inflammation of the joint is apt to ensue and to run a rapid course ending in complete disorganization, demanding amputation of the limb or cutting out of the joint—excision—to save the life of the patient.

Dislocation of the Spine.

The displacement of one vertebra from its position on another is seldom effected without fracture, except in the region of the neck. In the neck dislocation may occur between the axis and the atlas (p. 21). It has been pointed out (see p. 21) that the odontoid process of the axis moves in a ring of the atlas, that immediately behind is the canal of the spinal column, occupied by the spinal cord, and that separation between the odontoid process of the axis and the cord is effected by a ligament passing across between the two. Besides this ligament there are others, one passing upwards from the top of the process to the base of the skull, and two passing sideways to the base of the skull at the margins of the large opening—foramen magnum—through which the spinal cord passes to join the brain. These all aid in retaining the odontoid peg in its place. Nevertheless these ligaments may be ruptured, and the axis torn from its connections with the atlas above it. The result is that the peg is crushed backward upon the spinal cord, destroying it, causing instant death, for it is in this neighbourhood that the principal nerve centres exist which control the breathing, &c. This is one of the occurrences, and the immediately fatal occurrence, in "broken neck" from a fall or hanging.

Dislocations may occur in other parts of the spinal column, though they are, as has been said, rare without a fracture. The results are less serious the further down the column the dislocation happens to be. What has been said about fracture of the spine applies equally here, and reference should be made to that fracture. The signs of the two accidents are very similar.

The treatment also must fulfil the same conditions. Careful manipulation may be employed if any displacement of bone is apparent, to see whether any setting is possible. The head and shoulders may be fixed while the legs are being very gently pulled downwards. It is doubtful, however, whether any one but a surgeon ought to try this. In any case the utmost caution must be exercised. The injunctions given in discussing the treatment of fracture of the spine, namely, absolute rest, careful nursing, attention to the bowels, and in particular to the state of the bladder, and the regular use of the catheter, if required, avoidance of anything likely to encourage the formation of bed-sores, &c., all these must be constantly kept in view. In turning the patient shoulder and hip should be turned at the same time, so that movement of the spine may be prevented.

Dislocation of the Lower Jaw.

The movements of the lower jaw in chewing, yawning, and laughing cause its articulating processes to move forwards in the socket of the

joint, and it is by spasm of certain muscles during these movements that the bone may be jerked so far forwards as to be forced out of joint. Immediately in front of the socket is a small bony knob, which the bone slides over in the act of dislocation, and which bars the return of the bone to its socket. Fig. 48 represents this dislocation, * being opposite the socket, *r* being the articulating process of the lower jaw, and *k* the bony knob referred to. A blow on the chin, when the mouth is open, may also produce the dislocation, but it occurs most frequently in the act of yawning. It may be on one side only, or on both sides.

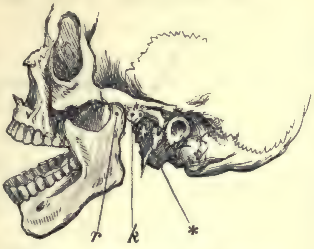


Fig. 48.—Dislocation of the Lower Jaw.

Signs.—When both sides are dislocated the mouth is fixed widely open; saliva dribbles from the mouth; the patient cannot speak nor swallow; and there is a hollow in front of the ear on each side, and above in front of this the prominence of the head of the bone. When the dislocation is on one side the chin is twisted towards the sound side. If the jaw is left alone, partial recovery takes place in course of time. The power of speech and of swallowing is gradually restored; the jaws come together to a considerable extent; and the saliva ceases to flow; but for a very long period great discomfort remains.

Treatment.—Let the operator stand in front of the patient and insert the thumb of each hand into the mouth, resting them on the teeth of the lower jaw. The thumbs must be well protected by lint or by a napkin wrapped round them. They should reach back to the last grinding tooth. The fingers are at the same time placed under the chin and base of the jaw. The patient's head being fixed against a wall or the back of a high chair, the operator presses the grinding teeth downwards with his thumbs, while raising the chin with his fingers. As soon as the bone becomes disengaged from its unnatural position the muscles pull it backwards into the joint. The return is effected suddenly, and the operator's thumbs are liable to be caught by the quick snapping closure of the mouth and seriously bruised, unless they have been properly protected. If the person is quick enough he may succeed in avoiding the snap by slipping his thumbs to the side between the gums and cheek. If this method of reduction fails greater power may be exerted by placing a piece of soft wood between the upper and lower grinding teeth on each side, the piece being thick enough to fill the space between them. The chin is then steadily pulled upwards, *but not forwards.* The pieces of wood act as a fulcrum for depressing the back teeth. A spoon or handle of a fork laid along the teeth would fulfil the same purpose.

After the reduction the chin ought to be confined for a time, a week or two, by a bandage to prevent renewed dislocation; and the person ought always afterwards to guard against opening the mouth too widely, as this is a dislocation which, once effected, is easily reproduced.

Partial dislocation of the jaw may occur, especially in people of relaxed habit of body. The symptoms are not so marked, but the mouth is fixed, and cannot be shut. A smart push may be sufficient to return the bone, and the person must exercise care in opening the mouth.

Dislocation of the Collar-bone (*Clavicle*).

The collar-bone is united to the breast-bone by means of a joint, at which dislocation may be produced by a fall on the shoulder or by a blow. The collar-bone may be displaced forwards, when the projecting end of the bone is easily felt, or it may be backwards, when symptoms of difficulty of breathing or of swallowing may be caused by the backward pressure of the displaced bone. Curvature of the spine has been known to produce this form of the dislocation. The bone may also be forced upwards.

Treatment consists in replacing the bone by drawing the shoulder outwards and backwards, while an assistant presses the head of the bone into its place. Thereafter the treatment for fracture of the collar-bone is to be employed, a pad being placed over the end of the bone to retain it in its place. The bone very easily slips out again, even though the greatest care to prevent it be exercised.

Dislocation of the Shoulder-blade (*Scapula*).

This has also been called a dislocation of the collar-bone, because it is the outer end of it that is forced out of position. A reference to Fig. 17 shows the connection between the outer end of the collar-bone and the projecting process of the shoulder-blade called the acromion process. In this form of dislocation the outer end of the clavicle is forced upwards on the process, that is to say, the process or point of the shoulder is

under the end of the collar-bone. Rarely, the positions are reversed.

Signs.—The shoulder is depressed and carried towards the breast-bone, the movements at the joint being restrained. On tracing the collar-bone outwards with the fingers its abnormal position can be made out.

Treatment.—Replacement is effected by pressure on the displaced bone, while the shoulder is pulled backwards. After replacing the bone the treatment is the same as for fractured collar-bone, with the addition of a pad made of several layers of soft cotton cloth applied over the outer end of the collar-bone and secured by a bandage passing downwards round the elbow, the arm being bent across the chest and bandaged in that position. The deformity is liable to return, and though it become permanent the use of the limb is not seriously impaired, since it adapts itself to the circumstances.

Dislocations of the Head of the Arm-bone (*Humerus*).

The head of the humerus in its natural position rests in the glenoid cavity (p. 21) of the scapula immediately under the acromion process (see Fig. 17, p. 21). It may be dislocated in three directions: (1) *downwards*, below the socket, into the arm-pit; (2) *forwards* in front of the socket, and slightly downwards; and (3) *backwards* on to the scapula, beneath its spine. The first form is called *sub-glenoid*, under the glenoid cavity, and is rare. The second form brings the head of the bone under the coracoid process of the scapula, and is called, therefore, *sub-coracoid. It is common.* The third form is called *sub-spinous*, because the head of the bone is under the spine of the scapula. It is very rare.

The second or sub-coracoid form is common because it is downwards and in front that the joint is least covered in and protected, muscles and bony processes guarding the joint in other directions.

The cause of the dislocation is most frequently a fall with the arm outstretched, the force being communicated along the arm, which acts as a lever. Occasionally direct violence forces the head of the bone downwards and forwards, a blow or fall on the shoulder for instance.

It is an accident of middle and advanced life, rare in childhood, though capable of being produced during that period of life by pulling and twisting. For instance, a mother or nurse may produce the accident when walking in the street holding a child by the hand, by suddenly and with a jerk pulling up the child if it slips, especially when stepping down off the curbstone.

The **Sub-coracoid** being the common form will be first described (Fig. 49).

Signs.—The roundness of the shoulder is gone, the tip of the shoulder projects outwards, and immediately beneath it, instead of the head of the bone, is a hollow. If the limb be raised the fingers can detect, in the arm-pit, a round body which rotates when the arm is bent at the elbow and turned outwards. The elbow sticks out from the side, and cannot be brought close. There is inability to move the arm at the shoulder, pain in the region of the joint, and sometimes numbness spreading down the arm to the finger owing to the head of the bone pressing on nerves. The limb is slightly shortened. The distinguishing features between dislocation of the head of the humerus and fracture of its upper end have been mentioned under FRACTURE OF THE HUMERUS (p. 42).

Fig. 49.—Sub-coracoid Dislocation of the Left Shoulder.

Treatment.—Strip the patient and place him sitting in the usual position in a chair. Let the operator stand behind him with one hand

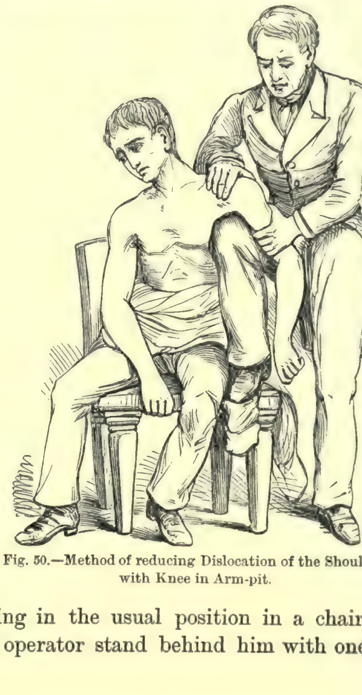


Fig. 50.—Method of reducing Dislocation of the Shoulder with Knee in Arm-pit.

over the shoulder-joint to fix the shoulder-blade. He then rests his foot on the edge of the chair, and thus brings his knee well up into the arm-pit, allowing the injured arm to hang over his leg. With the other hand he seizes the patient's arm near the elbow and depresses it steadily over his knee. The knee thus acts as a fulcrum, and the bone returns to its socket with a jerk. Fig. 50 shows this method. Greater force may be obtained by laying the

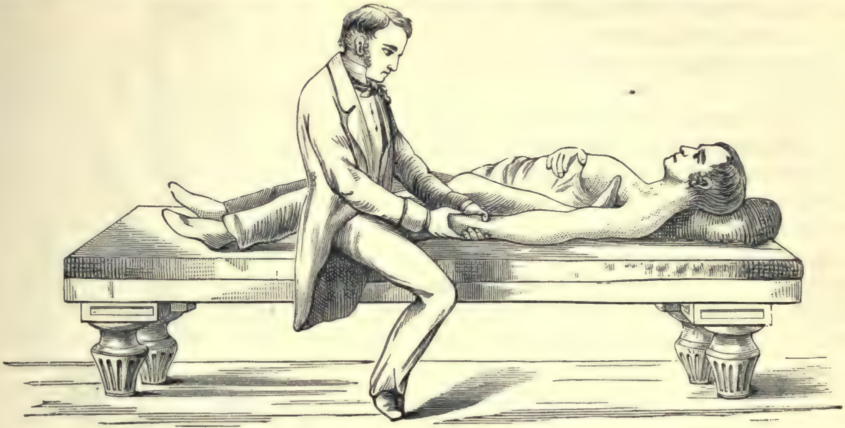


Fig. 51.—Reduction of Dislocation of the Shoulder by the Heel in the Arm-pit.

patient on his back on a couch. The operator sits on the edge of the couch by the affected side, and puts the heel of the foot next the patient well upwards and backwards into the arm-pit so as to fix the shoulder-blade with it. The boot must of course be removed. The arm is then grasped by both hands of the operator by the wrist or elbow, and pulled *firmly* and *steadily* downwards over the heel, which at the same time presses the head of the bone outwards. As soon as the reduction is complete, which is known by the loud snap, the extension should cease, and the forearm be brought across the chest, and there bandaged. This method is represented in Fig. 51, and is known as the method of the heel in the arm-pit. If pulling by hand on the wrist or elbow is not sufficient, greater power may be obtained by a large towel or skein of worsted arranged in a clove-hitch (see Fig. 52) fastened above the elbow. The force exerted by the clove-hitch may be further increased by tying the ends and throwing the loop over the head, letting it come round the back. The pulling can then be done by the back. In making extension it must always be remembered that the pulling must be steady and continuous so as to tire out the opposing muscles. If several days have elapsed since the accident, chloroform is advisable, supposing one competent to administer it be present. After a longer period it is necessary.

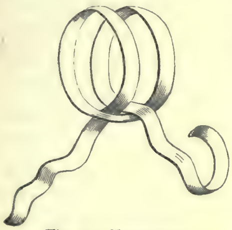


Fig. 52.—Clove-hitch.

Fig. 53.—Mode of reducing a Dislocated Shoulder without assistance.

A person may himself reduce his dislocated shoulder by the method represented in Fig. 53.

Sub-glenoid Dislocation (p. 21) presents similar signs to sub-coracoid, except that the arm is lengthened (Fig. 54). The treatment is identical, namely, the method by the heel in the arm-pit.

Fig. 54.—Sub-glenoid Dislocation of Left Shoulder.

Sub-spinous Dislocation is easily made out by the forward projection of the elbow, and the fulness behind the joint, where the head of the

bone can be felt on the back of the shoulder-blade.

Treatment.—The extension in this case must be made *forwards*, but the principles on which the reduction is effected are the same. The forward extension is easily effected after rolling the patient on to the dislocated side and supporting him in that position by a pillow under the sound side.

In all these cases, after reduction, the arm should be bandaged to the side and supported by a sling for some days to permit of irritation of the joint being allayed and the healing process being established. Violent exercise of the joint should be carefully avoided for months, even always, since the accident will occur again more easily. Swelling and pain after reduction should be relieved by warm fomentations and rest.

Neglected cases can be properly and effectually treated only by skilful surgeons.

Dislocations at the Elbow-joint.

The two bones radius and ulna may be dislocated together, or one of them separately. When both are together the dislocation may be backwards, or forwards, or to one side or other. The ulna may be displaced backwards alone and the radius forwards alone. Some of these varieties are very rare, because owing to the formation of the elbow-joint some of them would be extremely difficult to produce without great injury of other kinds to the joint. The commoner forms are dislocation of both bones backwards and dislocation of the radius alone forwards.

Dislocations of both bones backwards are commonest in childhood and youth. They are often due to a fall on the hand, the elbow being at the time bent. They can be produced by a blow on the lower part of the upper arm from behind driving it forwards, the elbow being fixed.

Signs.—The forearm is bent and fixed. The point of the elbow projects greatly behind, and above the projection is a hollow. In front the lower end of the upper arm-bone stands out prominently, and is pressed down into the bend of the elbow. (See FRACTURE OF LOWER END OF HUMERUS for the distinguishing features between it and this dislocation, p. 43.)

The signs of **ulna displaced alone** are the same, but exist only on one—the inner—side of the joint.

Treatment.—The simplest method is shown in the figure (Fig. 55). The patient is seated in a chair, the operator's foot rests on the chair, and his knee is placed in the bend of the patient's elbow, resting on the upper end of the forearm, *not on the lower end of the upper arm.*

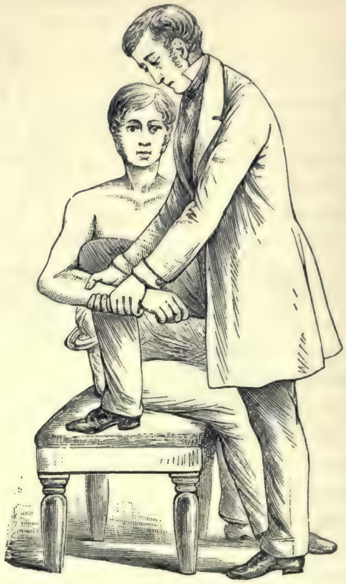


Fig. 55.—Reduction of Dislocation of Elbow.

The person's hand is then grasped, and the arm pulled round the knee. Another method is to permit one person to hold the upper arm fixed, while a second pulls on the forearm till the bones have been brought down into position. After reduction the arm should be kept in a sling for some days at least, and movement only gradually practised.

Dislocation of the Radius (p. 22) **alone** is generally forwards. It has frequently occurred in young children from a violent pull, as when they are lifted off the ground by the hand.

Signs.—The elbow is slightly bent, further bending being prevented by the upper arm-bone coming against the displaced end of the radius. Straightening of the arm causes pain. The head of the bone—the radius is on the thumb side—can be felt in its unusual position; and that it is the radius can be easily made out by turning the wrist with one hand while the fingers of the other hand are over the displaced end, which is then felt to turn.

Treatment.—Let an assistant, standing behind the patient, fix the upper arm. Press both thumbs down on the projecting head of the radius, and, at the same time, with the fingers grasping the forearm round about, pull on the forearm, and then bend it. The bone is re-

duced, but it comes out again very easily. If a pad over the reduced bone and a bandage fail to keep it in its place leave it alone. Through time the head of the bone gets absorbed, and the natural movement is restored.

Dislocations at the Wrist-joint.

Dislocation of the wrist-bones on to the forearm is now known to be extremely rare. Cases mistaken for it are most frequently cases of Colles' fracture of the radius.

The forms described are *backwards*, which, if it occurred, would be recognized by the mass of bone on the back of the forearm, projection of forearm bones in front, and bending inwards of the fingers on the palm, and *forwards*, when the mass of wrist-bones is in front and forearm bones behind.

To distinguish between fracture note the position of the projecting processes—styloid processes—of ulna and radius, one on the inside, the other on the outer side of the joint. If it is a dislocation these remain connected with the forearm, if a fracture they are displaced in the grip of the wrist-bones. See FRACTURE OF THE LOWER END OF THE RADIUS AND ULNA (p. 44).

The **Treatment** is simple extension by pulling on the hand and pressure exerted in the proper direction on the displaced wrist-bones. To retain the bones in position bandage the hand and wrist in a splint and suspend in a sling.

Sometimes one of the bones of the wrist—the os magnum, generally—is displaced from its connection with the others. Manipulation will restore it, and a firm pad must be worn over it for a time.

Dislocations of the Thumb and Fingers.

Dislocations of the thumb are not infrequent, because of the liability of the thumb to injury from falls. The common form is backwards, but dislocation forwards may occur. The thumb consists of three bones—the metacarpal, connected with the bones of the wrist and two phalanges (see Fig. 20, p. 22).

Now dislocation may occur at the joint between the wrist and metacarpal bone, or at the joint between the metacarpal bone and the first phalanx, or at the joint between the two phalanges.

The first is not common, the second and third are more common. The deformity in the second form is evident, the inner end of the first phalanx lies on the back of the outer end of the metacarpal bone, which projects strongly towards the palm. The thumb has thus got a peculiar double bend, and stands outwards sharply from the palm.

Treatment.—The difficulty in reduction is to get a large enough surface on which to make extension. If simple pulling by grasping the dislocated thumb with fingers and thumb, at the same time forcibly depressing the point of the thumb and drawing it downwards and forwards, is not sufficient, then place a clove-hitch (Fig. 52) on the thumb and pull with it. When these have failed then a thin strip of hard wood may be taken, 10 inches long and rather more than 1 inch wide, and shaped as shown in the figure (Fig. 56). At one end a series of holes is cut, through which strong tape about a yard long

Fig. 56.—Apparatus for Reduction of Dislocations of Thumb and Fingers.

is passed, a separate piece of tape being required for each pair of holes. Loops are thus formed on one side of the wood which secure the thumb laid along the wood. Extension can then be practised by pulling on the wood to which the thumb is fixed; and the reduction may be aided by bending backwards or forwards as may be required. Sometimes all these measures fail, owing, it is supposed, to the end of the bone being held by one of the muscles of the thumb, which must be cut before the bone can be returned.

Dislocation of the tip of the thumb may often be reduced by pressing the displaced end forwards with the thumb. After reduction a bandage should be applied to the thumb.

Dislocations of the Fingers are less frequent than those of the thumb. They also are backwards and forwards, usually backwards. They are easily recognized, and should be reduced by the methods described for the thumb.

Dislocations of the Thigh-bone (*Femur*).

Considering the depth of the socket in which the head of the thigh-bone moves, and the powerful muscles by which it is surrounded, this bone is dislocated with great frequency. This is, doubtless, because of the great range of movement permitted by the joint and the long leverage supplied by the leg to any displacing force. It requires both considerable force and a certain position of the limb to effect it. The accident is

commonest in middle life, but may happen to children.

There are two classes of dislocation: I. One class in which the head of the bone, displaced from its socket, rests *behind the socket;* and II. Another class in which it rests *in front of the socket.*

I. In the **backward displacement** it will be seen from Fig. 57 that the head of the bone, displaced from its socket (*a*), may lie (1) on the back of the iliac portion (A) of the hip-bone, in which case, besides being backwards, it is also upwards; or (2) the head of the bone may slip down and rest on the notch between the ilium and ischium, the sciatic notch (behind B in the fig.), and in this case the displacement is backwards, and not nearly so much upwards as in the former case.

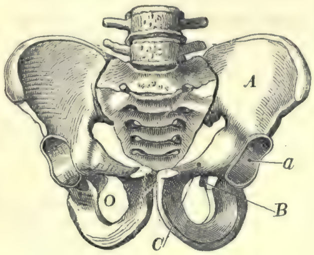


Fig. 57.—The Pelvic Bones.

II. In the **forward dislocations** (1) the head of the bone may drop down into the obturator foramen (O), or (2) it may be pulled upwards so as to rest on the body of the pubis (C).

I. (1) The common form is **backwards** and **upwards,** on the back of the ilium.

It will be easily understood that if the thigh be bent strongly up on the body, or, what is the same thing, the body bent, as in the stooping posture, and the limb at the same time brought close to the middle line of the body, the head of the femur will be brought to such a position in its socket that a sudden force may twist the bone out of the socket from its under side up on to the back of the hip. This is indeed the frequent way in which the dislocation is produced—a heavy weight, say a mass of earth, falling on the back whilst the body is bent forwards.

Signs.—When the patient stands on the sound leg the affected limb is seen to be shortened and turned inwards, so that the knee is in front of and above that of the unaffected side. The limb is slightly bent and supported by the toe, which rests on the opposite *instep* (Fig. 58, *a*). The head of the bone being directed backwards, and resting on the back of the hip, causes a marked prominence in that region, while the great trochanter, the process of the thigh-bone, which should project directly outwards, is now felt in front. The limb cannot be moved by the patient, and only very slightly by another person, and then with great pain. For distinctions between this accident and fractured thigh refer to FRACTURE OF UPPER END OF FEMUR, and see Fig. 40.

(2) The second form of this dislocation, in which the head of the bone rests on the sciatic notch, is a variety of (1), and is not half so frequent.

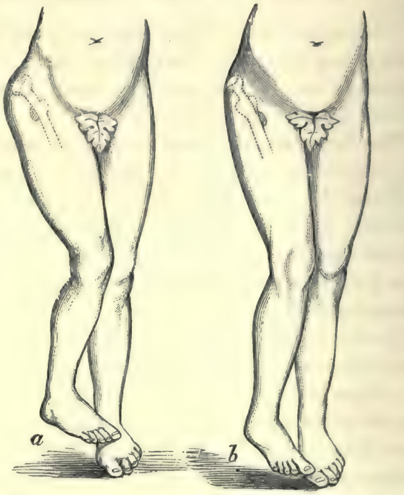


Fig. 58.—Dislocation of Hip, backwards and upwards. *a*, On to the Ilium. *b*, On the Sciatic Notch.

Its **Signs** are similar to those of (1), but less marked, as may be seen by reference to Fig. 58, *b*. The shortening is less, rarely exceeding $\frac{1}{2}$ inch, while the shortening in the first form may be from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. The point of the great toe rests on the *ball of the great toe* of the opposite side, a considerably less amount of support than in the former case. The projection backwards of the head of the bone is also less marked. These differences are well represented in the figure.

Treatment.—The treatment of both these forms is the same. Formerly sheer force alone was resorted to to effect reduction. Fig. 59 represents this method, in which the hip is fixed by a band passing between the legs and over the dislocated thigh, pressing, on the inside, against the front of the hip-bone, *not against the thigh-bone.* The band is attached to a staple in the wall or on the floor behind, and rather below the patient. Then, a padded leather belt is buckled to the lower part of the thigh and attached to one end of a pulley, which is fixed to the wall in front of the patient. The knee should be slightly bent and carried across the opposite thigh, as represented in the figure. The pulley or extending force, and the band or

counter-extending force, should act in the same straight line, and that ought to be the line of the displaced limb. When they are adjusted properly in this way extension is to be made by pulling slowly and steadily on the pulley until the head of the bone is brought down towards its socket, into which it may be caused to slip by gently rotating the limb. It sometimes catches on the edge of the socket, over which it may be lifted by means of a towel passed under the thigh as near the joint as possible. This method by force is, at least in recent cases, now superseded by a method by manipulation. It has been pointed out that the action that displaces the thigh-bone backwards is one which forcibly twists the limb inwards when it happens to be bent up on the body and carried towards the middle line. In other words, the dislocation is produced by flexion, adduction, and rotation *inwards*. Now by reproducing these manœuvres and reversing one of them the bone may be returned to its place. Thus the limb is bent, that is flexion; the knee is carried over the opposite thigh, that is adduction; but just at this point the dislocating action is reversed, and the limb is rotated *outwards*, so that the head of the bone is caused to return to the socket along the same path as that on which it had passed out from the socket, and is rolled back to its proper place. To carry out this procedure the patient is placed on his back. The operator stands in front of him, and taking the affected limb bends the knee on the thigh and the thigh on the body, and carries the knee so that it points over the opposite thigh. He then grasps the ankle with one hand and the knee with the other, and carries the limb upwards to and over the belly, passing outwards in a half sweep, and so back to its old position alongside the other leg. The rolling of the limb outwards must not be carried too far, lest the head of the bone be not rolled into its socket but round it, and the dislocation be changed from one backwards to one forwards. The sweep should, therefore, not be carried further outwards than the side of the body (Fig. 60).

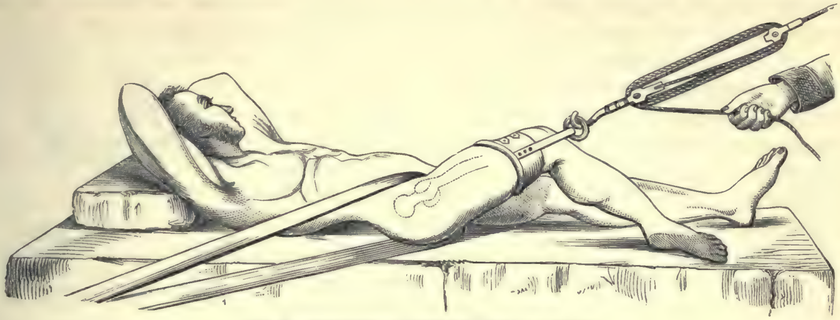


Fig. 59.—Reduction of Dislocated Thigh by Pulleys.

Another and simpler method, described as the "ready method," may be practised before trying the method by manipulation. It consists in laying the patient on his back on the ground. Let the operator stand over him, with the patient's injured leg between his legs, so that the ankle is between his thighs and the back of the foot pressing on his buttocks. Then the operator clasps his hands below the patient's bended knee, and by this means slowly lifts till the lower part of the patient's body is raised from the ground. After holding him so a few seconds he may hear the snap, which indicates the return of the bone to its socket. If this fails, then try manipulation, if manipulation fails pulleys may be necessary, but these should be used only by a surgeon. Chloroform is also frequently necessary.

Fig. 60.—Reduction of Dislocation of Hip by Manipulation—flexion, adduction, and rotation *outwards*.

After reduction the limb should be strapped to its fellow, and the patient kept at rest in bed for a fortnight.

II. The dislocations **forwards** are infrequent.

(1) When the dislocation is into the obturator foramen (p. 22) the limb is *lengthened* about 2 inches, drawn away—abducted—from the other, and in advance of it, and the foot points directly forwards. The body is bent forwards, and to the injured side. See Fig. 61, *d*.

(2) The second form, where the head of the bone rests on the body of the pubis, is the least frequent of all the dislocations of the hip.

Signs.—The limb is shortened about 1 inch, drawn away from its fellow, and turned outwards (Fig. 61, *c*). The roundness of the hip is lost. On moving the limb the head of the bone is seen rolling high up in the groin. The person cannot straighten himself, because the head of the bone stretches the muscles passing down the front of the thigh.

The force that causes either of these two forms differs in the method of its application from that causing the two backward dislocations. A violent separation of the thighs from one another may cause the first, such as a heavy weight falling on the back and forcing the limbs apart. To produce the second the thighs must be stretched out—*extended*—when a sudden forcing of the body backwards will cause it, or a sudden extension of the thighs when the body is fixed. The kind of movement most fitted to produce it is a sudden drawing outwards of the extended limb—extension and abduction—combined with twisting of the leg *outwards*—rotation outwards. These are the exact opposite of the movements necessary to produce the backward dislocations.

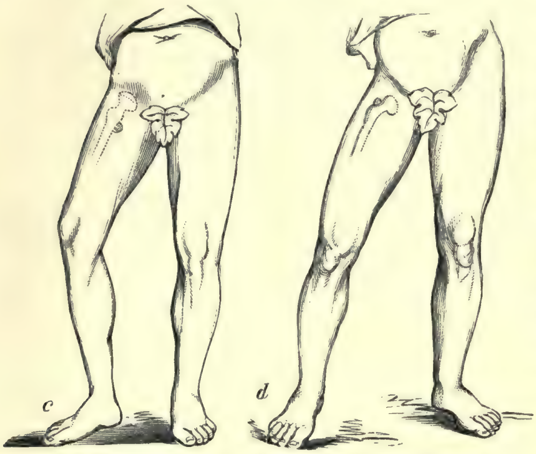


Fig. 61.—Dislocations of Hip forwards. *c*, On body of Pubis. *d*, Into Obturator Foramen.

The **Treatment** by manipulation is best, and applicable to both. It takes into view the movements that cause the dislocation, and reverses them to some extent. Thus the dislocating movements have been considered as extension, abduction, and rotation *outwards*, and therefore the manœuvres of reduction must be forced extension, abduction, and rotation *inwards*. The patient lies on his back, the operator stands over him, and grasps the ankle with one hand and the knee with the other. The thigh is bent so as to be perpendicular to the body, and the knee is bent. The limb is then taken well out from its fellow and carried in a sweep *inwards*, rotating the bone towards the body, the sweep ending when the limb is brought down straight alongside of the other (Fig. 62). In performing this movement one is apt, instead of reducing the dislocation, to convert it into one on the back of the hip, owing to the head of the bone travelling round the outside of its socket. If this has happened the manipulation for backward dislocation must be employed, and, to prevent the bone simply rolling round the socket, a towel may be used under the thigh with which to lift the head of the bone over the edge, as already described.

Fig. 62.—Reduction of forward Dislocation of the Hip by Manipulation—extension, abduction, and rotation *inwards*.

Another method of reducing (1) is to place the patient in bed with a bed-post close up between his legs, a small pillow being interposed between the post and the person. The operator stands on the sound side, and, passing his hand under the sound leg, grasps the ankle of the injured side, and pulls the foot and leg inwards across the middle line. By this means the bed-post is made to act as a fulcrum and the leg a lever for forcing the head of the bone outwards into its place. The object of passing the hand *under* the sound leg is to prevent raising the foot of the injured side, which would cause the head of the bone to roll round the socket into a notch behind. As in the former cases, after reduction the two legs should be bound together at the knee, and the patient should rest in bed for two weeks.

Dislocations at the Knee-joint.

The bones that form the knee-joint have been noted on p. 23. It is to be remembered that the joint is formed by the lower articulating processes, or condyles, of the hip-bone, and the

surface of the head of the tibia, that between these two there are crescent-shaped plates of fibrous gristle, and that the joint is strengthened by a large number of strong ligaments. Two ligaments—the crucial ligaments—are within the joint; the others surround it. The joint is protected in front by the patella or knee-pan, which has a ligament connecting its lower border with the tibia, and is attached by its upper border to the straight muscle that passes down the front of the thigh. The knee-pan glides up and down on the front of the joint. Now there may be dislocation of the pan, or dislocation of the tibia.

Dislocations of the Knee-pan.—The bone may be displaced to one side or other, or upwards, or it may be turned up on one of its edges. None of these occurrences is very frequent, but of the four forms the displacement outwards is the most common. It is most frequently due to falling on the inner side of the knee, but may be caused by sudden contraction of the straight muscle attached to the bone, as when a person makes a sudden jump, or a sudden effort to recover himself after a slip.

Signs.—On comparing the affected knee with the opposite side a great difference in shape is observed, and on examining with the fingers the knee-pan is found lying over the outer or inner condyle of the thigh-bone. The limb can neither be bent nor straightened, but is fixed in a slightly bent position. The breadth of the knee is increased.

When the bone has been drawn *upwards*, which is very rare, and cannot occur without tearing its ligament, it is found above the joint, and a hollow is in the place it ought to occupy.

With displacement *edgeways* a prominent body, which can be grasped by the fingers, is seen standing out under the skin. In this case the limb is immovably fixed in a straight position.

Treatment.—For *outward* or *inward* displacement, place the patient in a sitting posture, raise the leg, so that the heel rests on the shoulder of the operator, and push on the knee-cap with the fingers so as to restore it to its place.

Upward displacement requires to be treated as fractured knee-cap.

Displacement *edgeways* ought not to be treated till it is found which is the upper and which the lower surface of the bone. The upper surface may look outwards and the under surface inwards, or the reverse may be the case, and unless the position is made out the bone might be turned upside down. The best way of coming to a decision is to learn the direction of the dislocating force. If the force came from the outside it would be the upper surface that would look inward. Having found this out, put the patient in the same position as before, raise the heel and push the bone over with the thumbs.

After reduction the limb should be kept at rest in the extended position for some days at least, hot or cold cloths being applied if pain or any signs of inflammation exist. When the person begins to move about it is well to make a thick covering for the knee, which should be worn for several months.

Dislocations of the Shin-bone (*Tibia*).—Partial dislocations of the tibia to one side or the other with a slight turning of the bone may occur as the result of sudden twists given to the leg,—for instance, by the foot being caught in a hole, or by blows on the side of the limb. Complete dislocation backwards or forwards seldom occurs, however, without such destruction to the joint and structures in its neighbourhood as to demand amputation, because such a dislocation requires great force for production.

The **Signs** of the *side displacement* are so marked as to be easily observed. The leg and thigh are no longer in the same straight line, the tibia being displaced to one side; there is a bony prominence at one side owing to the new position of the head of the bone; and the joint is greatly increased in breadth.

The signs of displacement *backwards or forwards* are equally marked. When it is backward the shin-bone forms a projection in the ham, while the lower end of the hip-bone is very prominent in front, with a deep hollow *below;* when it is forward the swelling in the ham is owing to the condyles of the thigh-bone, that in front is owing to the head of the tibia, and the deep hollow is *above* the tibia. The leg is in both cases shortened. Besides these signs there are others due to the injury done to the soft parts round the joint. In particular the blood-vessels at the back of the joint may be severely pressed upon or injured, so severely sometimes as to arrest the circulation below the seat of injury and produce mortification of the limb. Nerves also may be harmed and numbness result.

Treatment.—For partial dislocations pulling from the ankle, combined with direct pressure on the head of the bone, is generally sufficient to return it to its place. For complete disloca-

tion extension must also be practised from the ankle, the thigh-bone being fixed, and pressure being exerted on the head of the tibia in a downward, and on the condyles of the thigh-bone in an upward, direction. Great care must afterwards be taken of the joint. It should be fixed and kept quiet for several weeks by means of a splint, or by being laid in a long box carefully padded, and, to allay inflammation, an ice-bag should be applied over the joint, flannel intervening between the skin and the bag. After recovery a firm bandage or elastic knee-cap should be worn.

Displacement of the Cartilages of the Knee-joint.—The half-moon shaped pieces of cartilages interposed between the thigh and leg bones sometimes become displaced. This accident generally happens after the cartilages have been affected by inflammation of the joint, a trifling cause, such as a slight twist of the foot when walking, being then sufficient to produce it.

The **Signs** are sudden and severe pain in the joint, which the patient cannot straighten. In a short time swelling and inflammation occur.

Treatment.—The patient having been laid on his back, grasp the limb in one hand, supporting it with the other hand in the hollow behind the joint, bend the knee to its utmost, and then suddenly straighten it, twisting the leg slightly backwards and forwards. If this is successful the patient has the use of the joint restored at once. It sometimes entirely fails, and the only remedy is to give support to the joint by a knee-cap. Sometimes a sudden accidental movement replaces the cartilage, after manipulation has failed.

Dislocation of the Clasp-bone (*Fibula*).—The head of the fibula lies just below the knee on the outside of the leg, and displacement can be readily made out.

The **Treatment** consists in strongly bending the knee, and pushing the bone back into position with the fingers. A pad should afterwards be placed over the head of the bone and secured by a bandage. This should be retained for two months.

Dislocations at the Ankle-joint.

The lower end of the shin and clasp bones together form a sort of arch which embraces the surface of the bone of the foot called astragalus or ankle-bone (Fig. 23, p. 23). The tibia on the inside and the fibula on the outside have projecting processes, the internal and external malleoli, which grasp the ankle-bone, so as to prevent any movement from side to side and limit it to a to-and-fro motion. The articular surfaces are further held in apposition by a ligament on each side, and one behind and in front. It will be readily seen, therefore, that the foot cannot be displaced from the leg to one side or other without breaking off one of the malleoli. In dislocation *outwards* part of the clasp-bone is broken off, producing the fracture known as Pott's which has been already described (p. 53); and in dislocation *inwards* a similar fracture of the shin-bone occurs. The latter is more serious because the force producing it requires to be greater. Both of them require to be treated as fractures.

Dislocation *backwards* is produced by jumping from a carriage in motion, or by a force which acts similarly by fixing the foot while the leg-bones are pushed forwards.

Signs.—The foot being pushed back the leg-bones are jerked forwards, and the distance between them and the toes is diminished, so that the back of the foot is shortened, and the heel lengthened. The toes are pointed down, the heel up. Forward dislocation is almost never seen. The signs would be the reverse of those of backward displacement.

Lastly, a form of dislocation exists in which the two bones are widely separated and the ankle-bone forced up between. It is accompanied by very great injury.

Treatment.—All these dislocations are reduced by pulling on the foot, the leg-bones being fixed, combined with proper manipulation. Afterwards a splint should be applied in front or behind, and inflammation kept under by hot or cold applications. After all risk has passed away the patient ought not to be allowed to go about until a starch or other stiff bandage has been applied to support the joint.

The ankle-joint is so liable to disease, and requires such care and skilful treatment after injury, that medical advice ought to be obtained whenever possible.

Dislocations of the Bones of the Foot.

Dislocation of a Tarsal Bone.—In the former dislocation the astragalus was separated from the bones of the leg, but it may retain its connection with the leg-bones and be separated from the other bones of the foot, from the heel-bone with which it is connected below, and from the scaphoid with which it unites in front.

The dislocation may be backwards or for-

wards, the latter very rare, outwards or inwards.

When dislocated *backwards* the foot is lengthened behind, and the ankle-bone is forced on to the instep, and when *outwards*, the foot rests on the inner border, the outer being raised, and there is a projection inwards of the tibia with the astragalus in its grip. In the inward dislocation of the foot, the fibula and astragalus form an outward projection, and the foot rests on the outer border, the inner being raised.

Treatment.—Fixing the leg-bones, pulling on the foot, and pressure exerted on the displaced bones will usually reduce them. Sometimes reduction is very difficult owing to wedging of the astragalus; and cutting through of certain tendons may be necessary. The after-treatment is the same as for other dislocations.

Dislocations of the Metatarsal Bones.—These sometimes occur as the result of great violence. Extension, counter-extension, and manipulation, as described for dislocation of the tarsus, are the proper means of restoring the bones to their position.

Dislocations of the Bones of the Toes (*Phalanges*).—The bones of the toes are seldom displaced; when they are, the displacement is upward, and is frequently combined with fracture. The treatment is the same as for reduction of dislocated fingers, the apparatus figured on page 61 being specially necessary.

Section III.—THE MUSCLES, TENDONS, AND BURSÆ.

A.—THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

Voluntary Muscle:
- *Microscopical Structure;*
- *Chemical Constitution*—rigor mortis;
- *Properties*—Irritability or power of responding to a stimulus, power of doing work, production of Heat and Electricity, Elasticity, Tonicity.

Involuntary Muscle:
- *Microscopical Structure.*

Particular Groups of Muscles—of head and neck—of the back—of the chest—of the upper extremity (shoulder, arm, forearm, and hand)—of the abdomen—of the lower extremity (thigh, leg, and foot).

Sheaths of Tendons.

Synovial Sacs or Bursæ.

While the bones form the framework of the body, the main bulk of the substance which clothes them consists of muscular tissue, what is termed flesh, which forms about two-fifths of the entire weight of the body. Muscular tissue does not cover and surround the bones in continuous sheets, but is collected into masses, varying in size and length and arranged in different ways. Each separate mass is called a muscle, and is divided off from its neighbours by partitions of connective tissue. Each muscle is supplied with blood-vessels, and with other vessels called lymphatics and nerves, which also have their sheaths of connective tissue; and vessels and nerves also run between muscles on their way to other parts. Over the muscles is a continuous sheet of fibrous tissue, having embedded in its substance a large number of fat cells. It is called **fascia**, and it not only covers over all the muscles, but fills up to some extent inequalities of surface, and gives a rounded and regular appearance. Finally, outside of all is the skin. So that if a limb were to be examined, say an arm, after the outer covering of the skin had been removed, the fascia, presenting a fatty appearance, would appear. When it in turn had been stripped off the various muscles would be revealed, inclosed in their sheaths and separable from one another. On pushing some of them aside vessels of various size and nerves would be visible, and not till the muscles had been stripped off would the bones be uncovered. Of course in some places, and particularly in the neighbourhood of joints, the bones come very near the surface, being covered by little else than fascia and skin.

The muscular tissue forming the masses is red in appearance, and it is therefore called **red muscle**. But there is another kind called **white muscle**, found in the walls of blood-vessels, in the coats of the stomach, bowels, and bladder, in the walls of the air-tubes of the

lungs, and elsewhere. Both kinds of muscle are the active agents in motion; but the movement caused by red muscle, for instance the motions of our limbs in walking, which are due to contractions of the muscles of leg, is a movement controlled by our will, while the white muscle exists in organs also capable of contractions, but contractions quite independent of our will. For this reason the red muscle is also called **voluntary** muscle, and the white **involuntary** muscle. Red muscle presents, when viewed under the microscope, a striped or striated appearance, while the white is smooth and regular; the one is therefore called **striped** or **striated** muscle, and the other **unstriped, non-striated**, or **smooth** muscle. A third variety of muscle is found in the heart (p. 218).

Structure of Voluntary Muscle.—If a small piece of muscle be examined under a microscope it is found to be made up of *fibres*, each fibre

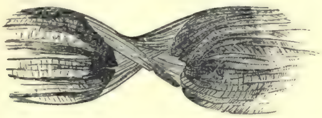


Fig. 63.—A Striped Muscular Fibre with its Sheath.

inclosed within a delicate transparent sheath, the *sarcolemma*. Fig. 63 shows a single fibre which has been torn, the torn ends have separated from one another, and the delicate sheath is seen passing across between the two. Each fibre can be split up lengthwise into a number of little fibres or *fibrillæ*, or crosswise into *discs*. The striated appearance is explained by supposing that a muscular fibre is made up of two kinds of substances, one doubly refractive, the truly contractile substance, which exists in the form of minute columns or pillars (sarcous elements) set in rows across the breadth of the fibre, embedded among the second singly refractive and non-contractile substance. A very slight amount of the embedding material is present between the columns of a row, so that they present the appearance of a continuous dark band. But there is a considerable accumulation of the embedding substance at the ends of the columns of one row, separating them by a clear-looking interval from those of the next row. Thus the dark band alternates with a light band, and the appearance of a cross striation is produced. Delicate membranes, connected with the sarcolemma, cross the fibre like partitions, dividing it into compartments, and these partitions pass across in the region of the accumulation of embedding material, appearing as dark lines in the light band. It is only by special means that these details of a muscular fibre can be revealed. Fibres are collected into bundles and inclosed in a connective tissue sheath to form what is called a *fasciculus*; and a number of the fasciculi

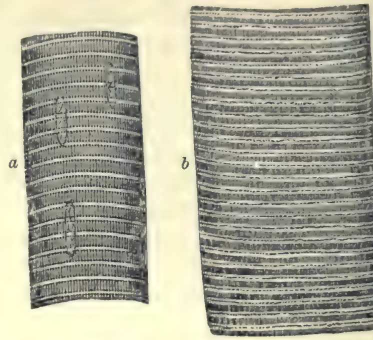


Fig. 64.—Muscular Fibre, *a* showing nuclei, and *b* the dark lines in the light band. In both are represented the minute columns mentioned in the text.

are bound together by a denser layer of connective tissue to form a muscle.

Muscle is richly supplied with very delicate thin-walled blood-vessels, which run up between the fibres and communicate with one another by cross branches. It is the blood that gives the red colour to the flesh. Nerves also are intimately connected with muscular fibres.

Chemical constitution of Voluntary Muscle.—Within its sheath a fibre in the living state is semifluid. The semifluid substance can be squeezed out, and is called **muscle plasma.** When allowed to stand the plasma coagulates, and then separates into a watery portion called **serum** and a solid portion or **clot**, which consists of a substance related to white of egg. The serum consists largely of water, but contains also a substance like white of egg, albuminous, that is to say, as well as animal starch, and salts, chiefly of potash, and waste substances formed by the action of the muscle. The clear semifluid substance of the fibres in the living state becomes after death opaque and coagulated. It is the occurrence of coagulation that produces stiffening of the body, or **rigor mortis** (the stiffness of death) as it is called, which comes on some time after the death of a person or an animal. The stiffening may come on *quickly*, within an hour or two after death or even sooner, if the person has died of an exhausting disease, and then it passes off quickly. The stiffening may be *long delayed*, as in the case of persons who have died in full vigour, by a sudden accident, for instance, and when it does at length occur it lasts long, and may continue even for several days. In both cases after *rigor mortis*

has disappeared the muscles become soft and flabby, and decomposition ensues.

Properties of Voluntary Muscle.—I. The great property of muscular tissue is *irritability* or the power of *responding when irritated.* The response is in the form of contraction, that is when the muscle is irritated or stimulated it responds by shortening itself, so that its ends are brought nearer and it becomes thicker at the middle. The muscle does not shorten itself all at once, but the contraction passes quickly over it in the form of a wave. The usual way in which a muscle is stimulated is by nervous action. The nerve-tubes end, it has been seen, in the fibres, and when a message is brought by the nerve the fibres become irritated and shorten themselves. Muscles, however, will respond to other than this usual stimulation. (1) Mechanical means, such as pricking or pinching, will irritate them and cause them to contract. (2) An electrical current has the same effect. (3) Heat also is capable of producing contractions as well as (4) chemical irritations. The purpose of contraction is obvious. If one end of the muscle be fixed, and the other attached to something which is free to move, when the muscle shortens itself it will bring whatever is attached to the one end nearer to the other.

A muscle will respond by a single contraction to each irritation if it be sufficient in amount, and will thereafter relax to be ready for the next contraction. Sometimes the irritations may follow so quickly after one another that the muscle has barely relaxed after one contraction when it is again called on to contract. If the irritations be still faster, then the muscle may not have time to relax at all between each one. The result is that the muscle remains contracted and rigid. This is the condition of a muscle in cramp, and is called **tetanus**. For instance, when a man seizes the handles of a galvanic machine while it is at work, if it be strong enough he finds he cannot let go, his fingers being firmly bent over them. This is due to tetanus of the muscles that bend his fingers, tetanus produced by a series of galvanic shocks causing contractions, the shocks being so rapid that the muscles have no time to relax and remain strongly contracted.

It is to be noted that when a muscle contracts owing to the stimulus received from a nerve it is not the nerve that supplied the force for contraction. The power of contraction is inherent in the muscle substance, and the stimulus only affords the opportunity for its display. The muscle has energy stored up within it as a barrel of gunpowder has energy stored up within it. The barrel of gunpowder, however, would stand harmless so long as it was left alone. As soon, however, as a lighted match is applied the energy of the gunpowder is liberated and an explosion occurs. So the stored up energy of a muscle requires merely to be set free to perform work. The nervous stimulus acts the part of the lighted match in liberating the imprisoned force of muscle.

II. Muscles by their contraction are *able to do work.* Thus if to the end of the muscle that is free to move a weight be attached, when the muscle contracts it will lift the weight. It is found, curiously enough, that a muscle contracts better when it has some weight to lift than when it has none. Up to a certain limit with increased weight there is increased work done. The increased resistance seems to call forth increased action of the muscle. When the limit has been passed the muscle quickly fails. Similarly a muscle works best with a certain degree of rapidity, but if the irritations follow one another too quickly, if the contractions are too rapid, the muscle becomes exhausted and *fatigue* arises. "It is the pace that kills."

III. Muscles *develop heat* by contraction.

IV. Living muscle has been shown to *possess a certain amount of electrical force,* which is diminished by contraction, but increases again with rest.

V. *Elasticity* is a property of this tissue, a property in virtue of which the muscle, after stretching, is capable of returning to its previous length.

VI. By *tonicity* is meant the condition of tension in which a muscle normally is. It is this condition of tension or tone that causes a muscle when cut to gape by separation of the edges of the wound.

Muscles are connected with bones not directly but through the medium of tendon. The mass of flesh tapers off as it were towards the ends, where the fibres pass suddenly into tendon, which consists of bundles of white fibrous tissue already described (Elementary Structures). The tendon presents the appearance of a white glistening cord, sometimes flat but often cylindrical, and of considerable thickness. The mass of flesh composing the muscle is called the *belly* of the muscle. One end is usually attached to a bone more or less fixed, and is called the *origin* of the muscle. The other end is attached to the bone meant to be moved by the contraction of the muscle, and is called the *insertion* of the muscle. Sometimes the tendon runs down the

centre of the muscle, and the fibres run obliquely into it, the tendon occupying the same position that the quill does in a feather. Sometimes again the tendon is spread out on the surface of the muscle in a flat expansion, in which case it is called an **aponeurosis.**

White, Involuntary, Non-striated, or Smooth Muscle consists of spindle-shaped cells, having an elongated nucleus in the centre (Fig. 65). The cells are united to form ribbon-shaped bands, not masses like those of striped muscle. This kind of muscle responds much less rapidly than the former kind to irritations, and the wave of contraction passes over it more slowly. It has been mentioned that this form of muscle is found in the walls of the stomach and bowels, and it is irregular and excessive contractions of the muscular walls of the bowel that produce the cramp-like pains of colic. Colic is, in fact, due to a cramp of involuntary muscle. The purpose of involuntary muscle in the walls of blood-vessels, stomach, &c., is mentioned in considering these organs.

Fig. 65. A Spindle Cell of Involuntary Muscle.

There are several hundreds of separate muscles in the human body. It would be quite unprofitable to go over them in any detail. It may be well, however, to indicate generally how they are grouped, and to mention a few in particular.

Muscles of the Head, Face, and Neck.

Various thin muscles are disposed in the fore part of the head and scalp (Pl. II. *fig. 1*), by which the brows can be "knitted," and the scalp moved to a small extent. Several small muscles are attached to the back of the ear, which are largely developed in animals with long ears, enabling the ears to be moved.

A series of thin muscles is disposed over the face, in the eye-lids, over the nose, and round the mouth, by whose contractions the various movements of the face are effected. They are called **muscles of expression.** When one side of the face is paralyzed, these muscles are quite relaxed, and so that side of the face is quite unwrinkled and expressionless. The muscles of the unaffected side being, therefore, unopposed, pull the face to that side by their tonicity.

The **temporal muscle** is a large fan-shaped muscle passing down the side of the head in front of the ear to be inserted into the upward projecting process of the lower jaw. Its action is to raise the lower jaw.

The temporal muscle forms one of a group of muscles, called **muscles of mastication,** because they are chiefly concerned in the movements of the jaw in chewing. The other members of the group are the **masseter** and **pterygoid** muscles, passing downwards from the neighbourhood of the zygomatic arch of the temporal bone to the lower jaw. Their fixed point is above, and they therefore pull the lower jaw upwards, bringing the lower in contact with the upper teeth, while they can also produce a grinding movement of the lower on the upper teeth. Opposed to them is a number of muscles situated in the neck, chief of which is the **digastric,** so called because it consists of two slender muscular bellies which are united by an interposed tendon. The tendon is attached to the hyoid bone, (H, Fig. 66) situated in the neck, to which one belly (1) passes from the base of the skull behind, while the anterior belly (2) passes upwards and forwards to the middle of the lower jaw-bone. When the muscle contracts it acts from its fixed point at the base of the skull, but the direction of action is changed by the attachment to the hyoid bone, which acts as a pulley, the lower jaw is therefore pulled down, and the mouth opened.

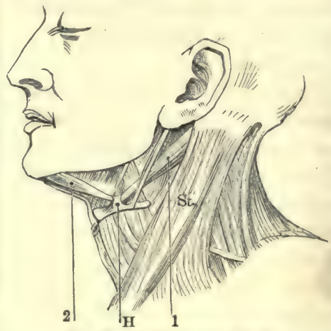
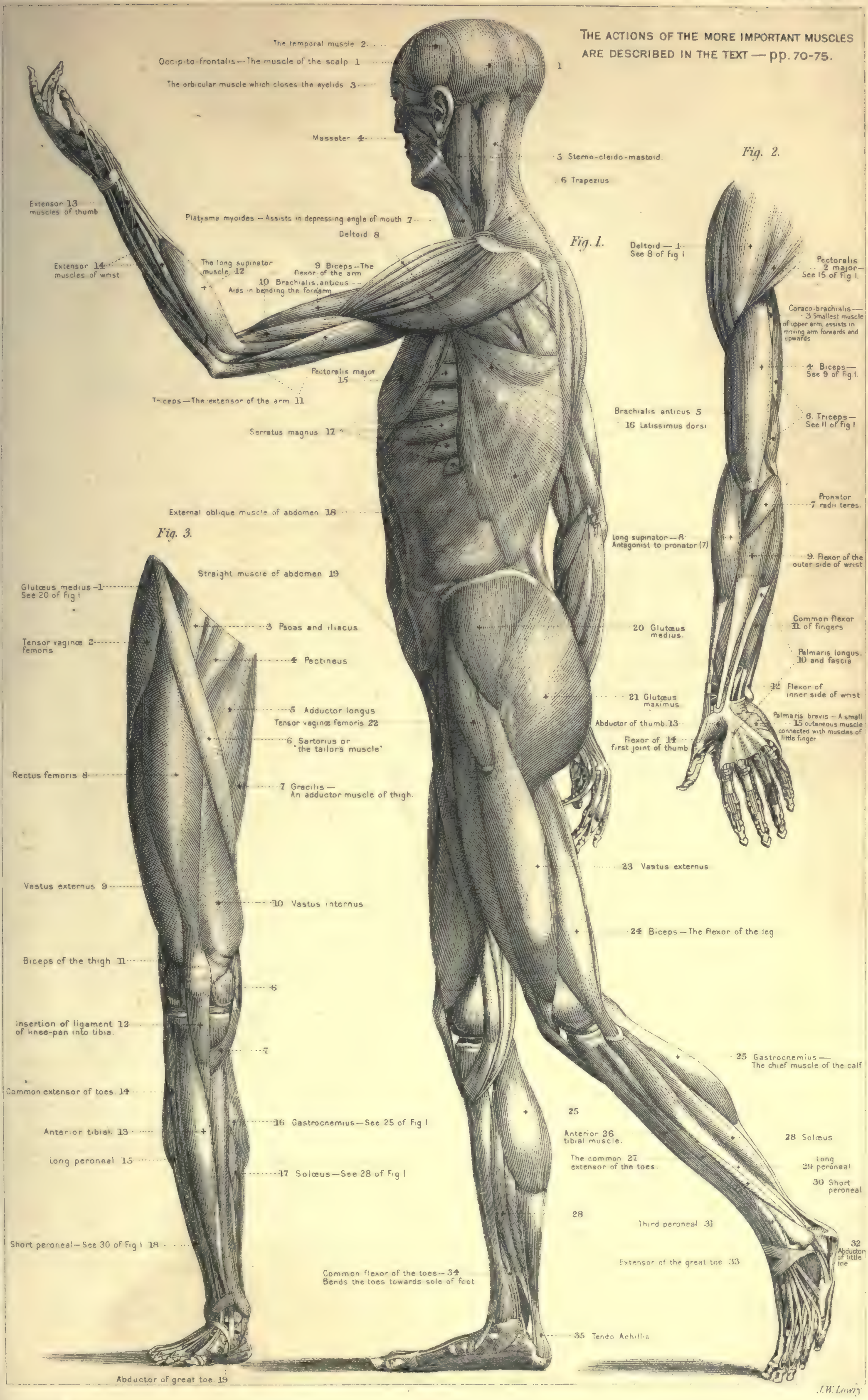


Fig. 66.—The Digastric Muscle.
1, Its posterior, 2, its anterior belly; H, hyoid bone; St., sterno-cleidomastoid muscle.

In the neck a large muscle passes from behind the ear down to the collar-bone in the neighbourhood of the breast-bone. When the neck is stretched, the projection of the muscle of each side can be easily made out, passing down obliquely near the middle line (St. Fig. 66). It is called the **sterno-cleidomastoid,** and by the contraction of the muscle of both sides the head is bent forwards. When the muscle of one side only acts the head is inclined to that side, and slightly turned so that the face and chin look to the opposite side. It is by the spasmodic action of this muscle that wry-neck is produced.

The **muscles of the eyeball** are discussed in the section devoted to the consideration of the eye.


THE ACTIONS OF THE MORE IMPORTANT MUSCLES ARE DESCRIBED IN THE TEXT — pp. 70-75.
Fig. 1.
The temporal muscle 2
Occipito-frontalis — The muscle of the scalp 1
The orbicular muscle which closes the eyelids 3
Masseter 4
5 Sterno-cleido-mastoid.
6 Trapezius
Extensor 13 muscles of thumb
Platysma myoides — Assists in depressing angle of mouth 7
Deltoid 8
Extensor 14 muscles of wrist
The long supinator muscle 12
9 Biceps — The flexor of the arm
10 Brachialis anticus — Aids in bending the forearm
Pectoralis major 15
Triceps — The extensor of the arm 11
Serratus magnus 17
Brachialis anticus 5
16 Latissimus dorsi
External oblique muscle of abdomen 18
Long supinator — 8 Antagonist to pronator (7)
Straight muscle of abdomen 19
20 Glutœus medius.
21 Glutœus maximus
Abductor of thumb 13
Flexor of 14 first joint of thumb
Tensor vaginœ femoris 22
23 Vastus externus
24 Biceps — The flexor of the leg
25 Gastrocnemius — The chief muscle of the calf
25
Anterior 26 tibial muscle.
The common 27 extensor of the toes.
28 Solœus
Long 29 peroneal
30 Short peroneal
28
Third peroneal 31
32 Abductor of little toe
Extensor of the great toe 33
Common flexor of the toes — 34 Bends the toes towards sole of foot
35 Tendo Achillis
Fig. 2.
Deltoid — 1 See 8 of Fig I
Pectoralis 2 major — See 15 of Fig I.
Coraco-brachialis — 3 Smallest muscle of upper arm, assists in moving arm forwards and upwards
4 Biceps — See 9 of Fig. I.
6. Triceps — See II of Fig I
Pronator 7 radii teres.
9. Flexor of the outer side of wrist
Common flexor 11 of fingers
Palmaris longus, 10 and fascia
12 Flexor of inner side of wrist
Palmaris brevis — A small 15 cutaneous muscle connected with muscles of little finger
Fig. 3.
Glutœus medius — 1 See 20 of Fig I
3 Psoas and iliacus
Tensor vaginœ 2 femoris
4 Pectineus
5 Adductor longus
6 Sartorius or "the tailor's muscle"
Rectus femoris 8
7 Gracilis — An adductor muscle of thigh.
Vastus externus 9
10 Vastus internus
Biceps of the thigh 11
6
Insertion of ligament 12 of knee-pan into tibia.
7
Common extensor of toes. 14
16 Gastrocnemius — See 25 of Fig I
Anterior tibial. 13
Long peroneal 15
17 Solœus — See 28 of Fig I
Short peroneal — See 30 of Fig I 18
Abductor of great toe. 19
J.W. Lowry

Muscles of the Back.

A great number of muscles massed together lies all along the back from the neck to the hip on each side of the middle line, filling up the hollow between the back-bone and the most projecting parts of the ribs. Their function is chiefly to straighten the back after it has been bent. Two muscles, placed above them, may be mentioned particularly. The **latissimus dorsi** (Pl. II. *fig. 1*, 16), or broad muscle of the back, is attached to the spines of the lower half of the back-bone and to the crest of the hip-bone, and passes upwards over the lower corner of the shoulder-blade, towards the armpit, which it covers in behind, to be inserted into a groove near the head of the upper arm-bone. Its position is shown in the figure. The action of this muscle is readily understood. If the arm be elevated it will pull it downwards and backwards, and owing to the position of the groove of the arm-bone, in which it is fixed, it will also turn the arm so that the palm looks backwards, making the arm perform the movement described in swimming. If, however, the arm be raised and fixed, the muscle will pull the body upwards towards the arm, as when the trunk is pulled up by the arms in climbing. The **trapezius** (Pl. II. *fig. 1*, 6) covers the upper part of the back, and arises from a ridge on the occipital bone of the skull, and from the spines of some of the cervical and all the dorsal vertebræ. The fibres spread outwards so as to be inserted into the outer portion of the collar-bone and the spine of the shoulder-blade. The muscles of the two sides are so disposed as to form a sort of "tippet," covering the upper part of the back, and stretching outwards to the shoulders. The trapezius elevates the shoulder if it acts from the head as the fixed point. If, however, the shoulder be counted the fixed point, the head will be pulled back towards one side if the muscle of that side only contract, and if the muscle of both sides contract, the head is thrown backwards, the chin being projected forwards by the movement. *These are the two chief muscles that attach the trunk to the upper limbs behind.*

Muscles of the Chest.

Some of the chest muscles will be more appropriately considered in the section on the respiratory system, since they are specially concerned in the act of breathing, and are therefore classified together under **muscles of respiration.** Under muscles of respiration is included the **diaphragm**, a muscle which forms an internal partition between the cavities of the chest and belly. Its action is also considered in the above-named section. Of the other muscles of the chest the chief are the **pectoralis major**, or larger chest muscle (Pl. II. *fig. 1*, 15), and the **pectoralis minor**, or smaller chest muscle, and the **serratus magnus.** The first rises partly from the anterior portion of the collar-bone, partly from the breast-bone, and partly from the cartilages of the ribs, and passing in front of the arm-pit, is inserted into the side of the groove in the upper arm-bone. It is the opponent of the broad muscle of the back to this extent, that it draws the arm forwards, while it co-operates with the muscle of the back in pulling the limb down from the elevated position. If the arm be fixed in the elevated position, then it co-operates with the broad muscle in pulling the trunk up towards it. The **pectoralis minor** lies beneath the upper part of the major, and is inserted into the coracoid process of the shoulder-blade, which it depresses, thus opposing the trapezius. The **serratus magnus** muscle (Pl. II. *fig. 1*, 17) is in contact with the ribs in the upper and side part of the chest, rising by nine fleshy slips from eight upper ribs, and it stretches across to the shoulder-blade to which it is attached. If the ribs be fixed it pulls the shoulder-blade from the spinal column, and allows the arm to be farther outstretched; if the shoulder-blade be fixed, the serratus magnus pulling from it will raise the ribs. *These are the principal muscles that attach the trunk to the upper limbs in front.*

Muscles of the Upper Extremity.

The muscles that attach the upper extremity to the trunk in front and behind have already been sufficiently mentioned.

Muscles of the Shoulder.—The chief muscle of the shoulder is the **deltoid** (Pl. II. *fig. 1*, 8). It springs in front from the outer portion of the collar-bone, from the tip of the shoulder—the acromion process of the shoulder-blade—as well as from the spine of the shoulder-blade, thus overlapping the most prominent part of the shoulder. From this it converges downwards over a third of the upper arm, till it is inserted into a rough surface on the outer side, and about the middle of the upper arm-bone. By its contraction the arm is raised from the side till it is at right angles with the trunk. For

further elevation the action of the trapezius is necessary. Several other muscles pass to the shoulder from the upper and under surfaces of the shoulder-blade.

Muscles of the Arm. They are classed together as either *flexors*, that is muscles that bend the arm through the medium of the elbow-joint, or *extensors*, muscles that straighten the elbow-joint. The main flexor is the **biceps** (Fig. 67, *a*), so called because it has two heads, one from the coracoid process of the shoulder-blade, the other from the upper edge of the socket in the shoulder-blade for the reception of the head of the arm-bone. Its tendon passes over the elbow-joint, and is inserted into a rough prominence near the head of the radius—the outer of the forearm bones. When this muscle contracts, the forearm is bent up on the upper arm, and if anything be held in the hand, heavy enough to offer resistance to this movement, then the muscle is seen standing out in front of the upper arm. The chief opponent of the biceps

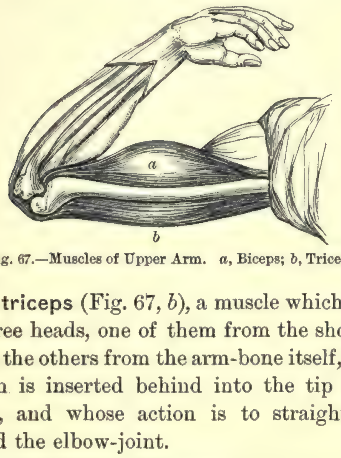


Fig. 67.—Muscles of Upper Arm. *a*, Biceps; *b*, Triceps.

is the **triceps** (Fig. 67, *b*), a muscle which arises by three heads, one of them from the shoulder-blade, the others from the arm-bone itself, whose tendon is inserted behind into the tip of the elbow, and whose action is to straighten or extend the elbow-joint.

Muscles of the Forearm. The muscles of the forearm are divided into four classes:

I. *Flexors*, those which bend the hand at the wrist-joint and also bend the fingers, and II. their opponents the *extensors*, which straighten the hand and fingers, III. the *pronators*, which turn the radius (p. 22) and with it the hand, which it carries, palm downwards, and IV. their opponents, the *supinators*, which rotate the radius back again, and so turn the palm upwards.

I. All the flexors spring from the *inner* projection of the lower end of the upper arm-bone, and pass down *the front* of the arm. One set is devoted to bending the wrist-joint, one on the outer the other on the inner side, another set to bending the fingers. Of those that bend the fingers there is a superficial and a deep set, the superficial having four tendons, one for each finger, which are inserted into the second phalanx of each of the four fingers. The deep set has also four tendons which pass up the front

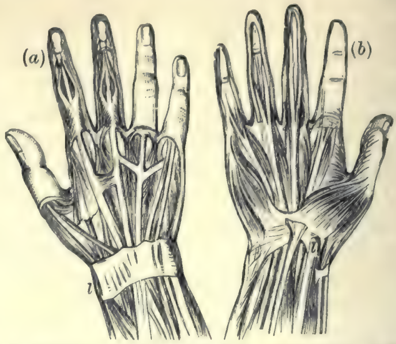


Fig. 68.—Muscles and Tendons (*a*) of Back and (*b*) of Palm of Hand.

of the fingers, pierce the superficial tendons and pass on to be inserted in the base of the last phalanx of each finger. So that the tendons of the deep set bend the fingers at the first joint, those of the superficial set bend them at the second joint. The thumb has a separate flexor muscle. Fig. 68 (*b*) shows these arrangements.

II. On the *back* of the forearm and arising from the *outer* prominence or condyle of the upper arm-bone are the *extensor* muscles. There are extensors of the wrist and extensors of the fingers. The extensors of the wrist are three in number, two on the outer and one on the inner side. There is an extensor common to the four fingers having four tendons, one to each finger, which are attached to the first and second phalanges, and end upon the last phalanx, of each finger. The tendon of the ring finger is attached on one side to that of the little finger, and on the other to that of the middle finger, so that if the middle and little fingers are bent, the ring finger cannot be straightened, being held down by them. Fig. 68 (*a*). The thumb has three extensor muscles of its own, one attached to the base of its metacarpal bone, one to the first, and the other to the second phalanx. The first and second fingers have also special extensors of their own.

The tendons of the flexor and extensor muscles are bound down as they pass over the wrist into the hand by a strong band of fibres called the *annular* ligament, because it surrounds the wrist like a ring (see Fig. 68, *l*).

III. The chief *pronator* muscle is called **pronator radii teres**, and is in front of the arm and at the upper part (Pl. II. *fig. 2*, 7). It rises from the inner prominence of the arm-bone, and passes obliquely to be attached to the

outer side of the radius about its middle. When it contracts it causes the radius to roll over the ulna, and as it carries the hand the palm is turned down. It is opposed by

IV. The *supinator* muscles, which are on the back of the forearm, and are so attached to the radius as to turn it back to its former position, making the hand turn palm upwards.

Muscles of the Hand. Muscles lie in the spaces between the bones of the palm called **interossei** muscles. The thumb has a series of muscles, one for bending it, another for drawing it from the middle line, a third for approaching it to the middle line, and still another for opposing it to the other fingers. Similarly the little finger has its special flexor, its abductor and adductor muscles, as well as one for opposing it to the thumb.

Muscles of the Abdomen.

The walls of the abdomen or belly are formed mainly of muscles, which are in several layers, and are supplemented by fibrous sheets called aponeuroses. The muscles run an oblique course between the ribs above the crest of the hip-bone below. Low down in the line of the groin the aponeurosis is gathered together to form a broad band, called **Poupart's ligament**, which runs from the crest of the ilium to the projection of the pubis in front (p. 22). This ligament will be referred to in discussing rupture. A straight muscle runs down the front of the belly on each side of the middle line from the ribs to the pubis—the **rectus** (straight) muscle of the belly.

The abdominal muscles give support to the organs which they help to inclose. By their contractions, if the chest and pelvis are fixed, they can also press on the inclosed organs, and aid, for instance, in vomiting or in the expulsion of matters from the bowel or bladder. They can also draw down the ribs, or, if the back be not kept fixed, will bend the chest forwards; or, if the chest be fixed, they can draw up the pelvis, as in the action of climbing.

Muscles of the Lower Extremity.

Muscles of the Thigh. In front of the thigh there are two muscles arising from the front of the back-bone in the lumbar region, and from the hollow of the haunch-bone. They pass over the edge of the pelvic bones to the thigh-bone, and become attached to the small trochanter of that bone, which, as already described (p. 23), is a prominence below the head of the thigh-bone directed inwards. They are called the **psoas** and **iliacus** muscles.

The office of these muscles is to *bend the hip-joint.* In other words, if we suppose their place of origin from the bodies of the vertebræ to be fixed, by their contraction they will bend the thigh up on the pelvis, or, if the attachment to the thigh-bone be fixed, if the leg be kept stationary, they will bend the body over the thigh. Opposed to the iliacus and psoas is the great mass of muscle that forms the buttocks. The mass is composed of several muscles which arise from the back of the haunch-bone, and are inserted by tendons into the thigh-bone in the neighbourhood of the great trochanter—the outer prominence of the thigh-bone. Thus, if the pelvis be fixed, the action of these muscles will *extend the hip-joint.* That is to say, suppose the thigh has been bent up on the pelvis, the muscles of the buttock will pull it down and bring it into line with the body. Suppose, however, the legs to be fixed and the body to be bent forwards, then the muscles will act from their attachment to the thigh-bone as the fixed point, and will straighten the trunk, restoring the erect posture. These muscles are, therefore, for this purpose largely developed in man. There are three muscles in particular which compose the mass of muscle referred to. They are called respectively **gluteus maximus** (Pl. II. *fig. 1*, 21), which forms the greatest prominence of the region, and whose margin forms the fold of the buttocks, the **gluteus medius** and **gluteus minimus** lying below the first, or the greatest, middle sized, and smallest glutei muscles. It is the largest of the three that is the chief extensor, the other two are also *abductors* of the thigh, that is, they draw the thigh away from the middle line. Associated with them is a number of smaller muscles that pass outwards and across from the pelvic bones to the thigh-bone, whose action is to turn the leg outwards. They are the *rotators outwards* of the thigh. They also support the hip-joint behind.

To oppose the abducting action of the smaller glutei muscles, there is a group of three muscles called *adductors*, namely, the **adductor magnus, longus**, and **brevis** (the great, long, and short adductors). They arise from the pubis, the front portion of the pelvic bones, and are attached to the thigh-bone, the first three uniting to occupy the whole rough line on the back of the bone. Being thus inserted at the back of the bone, they rotate it outwards while bringing it to the middle line, and they can

also bend the thigh on the pelvis, or the pelvis on the thigh. These muscles are augmented by others which need not be particularized. To summarize, the muscles that pass between the pelvis and the thigh may be divided into the following groups:—I. *flexors*, passing over the hip-joint in front; II. *extensors*, placed in the region of the buttocks; III. *rotators outwards*, passing across between pelvis and femur behind; IV. *abductors*, also behind; V. *adductors*, in front and to the inside of the thigh.

There still remains a number of muscles attached to the thigh in front and behind. They are separated from the others by the fact that they pass beyond the thigh to become inserted below the knee-joint, and thus act principally on the knee-joint. They are divisible into two groups—I. *flexors* of the knee-joint, and II. *extensors* of the knee-joint.

I. The hamstring muscles are the *flexors*. They are three in number, and all arise from the prominence of the hip-bone (the tuberosity of the ischium) that forms the seat. One of them, called **biceps**, is attached to the head of the clasp-bone, the outer of the two bones of the leg, and is the outer of the hamstring muscles; the other two, **semitendinosus** and **semimembranosus**, are attached to the shin-bone on the inner side of the knee. When the three muscles act from the hip as their fixed point they will bend the knee-joint; and when the knee-joint is fixed they will extend the hip, that is, straighten the trunk. The **sartorius**, or tailor's muscle (Pl. II. *fig. 3*, 6), is a long, slender, ribbon-shaped muscle, which stretches from the upper projecting process of the hip in front across the front thigh to the inner side of the knee-joint, where it is attached to the shin-bone. It bends the hip and knee-joints, at the same time directing the knee outwards, so producing the posture assumed by tailors. Hence its name.

The semitendinosus and sartorius muscles are also *rotators inwards* at the knee-joint.

The flexors are opposed by—

II. The *extensor* of the knee-joint, which is properly one muscle, but divisible into four parts. It occupies the whole front and sides of the thigh. One distinct part is the **rectus**, or straight muscle, marked 8 on the plate (fig. 3), which passes from the hip-bone straight down the front of the thigh till it ends in a broad, flat tendon, inserted into the upper surface of the knee-pan.

The lower edge of the knee-pan has another ligament which passes down to be inserted in front of the shin-bone, so that the rectus muscle is practically attached to the front of the tibia. The rectus is supported on each side by an extensive sheet of muscle, which is inserted into the same tendon, 12 of plate (fig. 3). When this large extensor muscle acts from its attachment to the hip, it straightens the leg by extending the knee-joint. When the knee-joint is extended and fixed, the contraction of the muscle will flex the hip, that is, bend the trunk forwards.

Muscles of the Leg and Foot. In the foreleg the space between the shin and clasp bones in front of the leg is occupied by muscles which extend the foot. There is the **long extensor** of the toes, whose tendon runs over the back of the foot in four slips, one for each of the four outer toes. The tendon for the great toe is derived from a special muscle placed on the leg close to the long extensor. There is a third muscle (the **anterior tibial**) lying close against the tibia, whose tendon turns over the back of the foot at the instep to be inserted into the interval of the wedge-shaped bones of the tarsus. This is the muscle which raises the inner side of the foot, and spasm of which produces one form of club-foot. On the outer side of the leg is another muscle (the **third peroneal**), whose muscle turns over the outside of the foot in a manner similar to the foregoing. It raises the outer side of the foot; and spasm of it produces a second variety of club-foot.

On the outer aspect of the leg are two muscles (the **long** and **short peroneal**), whose tendons pass behind the external malleolus to be inserted, the former into the base of the metatarsal bone of the great toe, and the latter into the metatarsal bone of the little toe. They extend the foot and give it an outward direction, while they strengthen the arch of the foot.

On the back of the foot is the **short extensor of the toes**, whose tendons, one to each of the four inner toes, join those of the long extensor. The arrangement of the extensor tendons of the toes is exactly similar to the arrangement of those of the fingers.

On the back of the leg there are too large muscles, **gastrocnemius** (Pl. II. *fig. 1*, 25) and **soleus**, which form the bulk of the calf of the leg. The former is the larger, and arises from the condyles of the thigh-bone; the latter is beneath it, and arises from the heads of tibia and fibula. Both are united in a common tendon, the thickest and strongest in the body, the **tendo Achillis**, so called from the old Greek fable, according to which Achilles was dipped by his mother into the river Styx, and so made

invulnerable. He was held by this tendon, which, therefore, did not get immersed, and so remained capable of being wounded, the only vulnerable part of his body; and here he was in the end fatally wounded. The tendo Achillis is inserted into the back part of the projection of the heel-bone, the os calcis (Fig. 69). The two muscles, acting through the tendon, pull up the heel, and so raise the body on the toes. They are used in walking, jumping, &c. Beneath the calf muscles are the **long flexor of the toes** and the **special flexor muscle of the great toe.** The tendons pass behind the internal malleolus—the inner projection of the tibia at the ankle-joint—to reach the sole of the foot, where the long flexor divides into four slips, one for the end bone of each of the four outer toes. The tendon of the special flexor of the great toe proceeds to the last phalanx of that toe. In the sole of the foot itself is the **short flexor of the toes.** It arises from the heel-bone, and has four tendons, one for the second phalanx of each of the four outer toes. The tendons of the long flexor, in their passage to the last phalanges, pierce those of the short flexor. At the back of the leg, between the two bones, is the **posterior tibial** muscle, whose tendon passes beneath the internal malleolus to reach the scaphoid bone, to which it is attached. It extends the foot and gives it an inward direction. In the sole of the foot there are special muscles for bending, and directing outwards or inwards the great toe, and for bending and abducting the little toe, as in the hand for the thumb and little finger. Besides, there are **interossei** muscles, also, as in the hand, running between the metatarsal bones, arranged for moving the toes to one side or another.

Fig. 69.—The Tendo Achillis.

In the sole of the foot a strong fibrous tissue, the **plantar fascia,** covers the muscles and extends from the heel-bone forward to the toes. It has a central and two side portions, the central portion being separated from the side portions by fibrous partitions which sink between the muscles deeply into the sole of the foot. When abscesses occur in the sole of the foot the plantar fascia confines the matter that is formed, and thus prevents it spreading. At the same time it prevents it working its way to the surface, so firmly does the fascia bend down the tissue. For this reason abscesses in the foot are often very troublesome to deal with, and very painful.

Synovial Sheaths or Sacs.

It will be readily understood that the tendinous cords moving so frequently on the surfaces of bone, and over bony prominences, would be liable to develop friction and heat to an extent that might be injurious, unless some means existed for rendering the motion as easy as possible. This is effected by means of sheaths which surround tendons. The sheaths form a double lining round the tendons, and the opposed surfaces are lined by synovial membrane, already noticed as one of the structures entering into the formation of joints. The membrane secretes the fluid synovia, which lubricates the sheath in which the tendon slides, and so facilitates the motion. Such synovial sheaths are specially well marked in the tendons of the hand and foot.

Besides sheaths lined with synovial membrane, little sacs similarly lined, and containing fluid, exist in special places between two surfaces which move upon one another to any great extent. Such sacs are called **synovial sacs,** or **synovial bursæ,** or simply **bursæ.** For instance, the movement of the knee-pan in front of the knee-joint has been already referred to. This motion, so constant in walking, would be sure to produce undue friction and heat, and consequent inflammation, were it not for the interposition of such a sac between the upper surface of the joint and the deep surface of the knee-pan. Again, the knee-pan moves underneath the skin, and, to prevent friction between its upper surface and the skin, another synovial sac or bursa is interposed. So that the knee-pan is between two bursæ, one superficial, just under the skin, the other deep beneath the bone. Similar, though smaller, sacs are found over the point of the elbow, over the knuckles, over the malleoli—the outer and inner projections of the ankle-joint—and over various other prominent points, the great trochanter of the thigh-bone for example. They may also be present between two tendons or two muscles. It is important to notice the bursæ, as they fulfil a very important duty, and are besides liable to disease, and specially to various forms of inflammation.

Section III.—THE MUSCLES, TENDONS, AND BURSÆ.

B.—THEIR DISEASES AND INJURIES.

Diseases of Muscle:
Wasting and Overgrowth (Atrophy and Hypertrophy)
Muscular Spasm—Cramp,
Bather's, Writer's, Pianist's Cramp—Stiff-neck—Wry-neck.
Diseases of Tendons and Bursæ:
Simple Inflammation;
Whitlow;
Ganglion;
Enlargement of Bursæ—Housemaid's Knee—Miner's Elbow.
Bunion.
Injuries of Muscle and Tendon:
Rupture;
Sprain.

DISEASES OF MUSCLE.

I. Wasting and Overgrowth (*Atrophy and Hypertrophy*).

1. **Wasting** (*atrophy*, Greek *a*, not, and *trepho*, I nourish) may arise in muscle from changes in the nourishment of the part, from want of exercise, or from a nervous disease. Thus an arm that has been kept up for some weeks in splints because of fracture will, when unbound, be found very much thinner and weaker than its neighbour, owing to the enforced want of exercise. Sometimes, after a fever, cold, or other disease, one arm or leg or both legs become chilly, benumbed, and thin, and, in the case of children, cease growing in proportion to the rest of the body. An injury to an arm or leg involving a nerve of the limb, may lead to wasting of the muscles to which the nerve proceeds. There is a disease of the spinal cord which causes rapid wasting. (See Progressive Muscular Atrophy under Diseases of the Nervous System.)

Treatment.—Good food and exercise and the use of quinine and iron and similar tonics are the general remedies ordered for muscular wasting. Rubbing the affected parts with stimulating liniments, such as the liniment of camphor and ammonia (see Appendix of Prescriptions) is of value.

2. **Overgrowth** (*hypertrophy*, Greek *huper*, beyond what is usual, and *trepho*, I nourish) is a condition of increased nutrition. The arm of the blacksmith, for example, has muscles which exhibit greater growth than usual, owing to the stimulus of exercise; and this is quite natural.

In children there sometimes occurs a nervous disease which produces apparent increased growth of muscle, particularly of the buttocks and back of the legs. The increase is only apparent, however, so far as the muscles are concerned. They are actually wasted, and the increased bulk is of fat and connective tissue. Weakness is a marked symptom of the disease, paralysis ensues, and death results.

Electricity is the only remedy that seems of advantage. (See Pseudo-Hypertrophic Paralysis, under Diseases of the Nervous System.)

II. Muscular Spasm—Cramp.

1. **Cramp.** By this is meant the spasmodic and involuntary contractions of the muscles of the body, either those which are under the control of the will or *voluntary* muscles, or those which are not subject to the will, the *involuntary* muscles. As an example of cramp in the voluntary muscles, may be taken those severe pains experienced in the legs, feet, hands, and fingers; and of cramp in the involuntary muscles, cramp of the stomach and of the bowels (colic), may be taken as examples. Cramp is attended by rigidity and pain, and usually passes off in a brief space of time. It may be a mere symptom in the course of some other disease, for example in cholera; and is liable to arise when the general health is affected by indigestion, rheumatism, gout, bloodlessness, pregnancy, &c.

While it may occur in any muscle, it is most common in the muscles of the calf of the leg. There are some persons who are peculiarly subject to cramp, a certain position of the limbs, for example crossing the legs, being sufficient to

induce it. Many fatal accidents have occurred to bathers from their being seized with cramp of the limbs. The attack has a sudden onset, is accompanied by a rigid state of the muscle and severe pain, and is usually of a few minutes' duration, though it may last for several hours.

Treatment.—An endeavour must be made to *prevent* attacks of cramp by due care as regards the diet, and proper regulation of the bowels. To regulate the bowels, small doses of rhubarb with bicarbonate of soda (baking-soda) will be found very efficient, the former being given in doses of 8 to 10, the latter in doses of 12 to 20 grains.

When the attack is due to some general disease, such as those already mentioned, that general disease must be treated.

During an attack of cramp, the affected limb should be firmly grasped, forcibly straightened and rubbed with the hands. If friction prove unsuccessful the part should be put in hot water and afterwards diligently rubbed with a liniment of soap and opium, chloroform, or laudanum. *Cramp in the stomach* is usually caused by the presence of some undigested article of food, and is a common symptom in *indigestion*. For its treatment, see DISEASES OF THE STOMACH.

2. **Bather's Cramp.** Many fatal accidents have occurred to bathers from their being seized with cramp in the limbs. Sometimes the spasm may seize almost all the voluntary muscles, and render it impossible for even the most expert and cool-headed swimmer to save himself. The cause seems to be the sudden shock of cold applied to the body. It occurs most readily when the body is very warm, and in vigorous persons after prolonged muscular exertion. Thus swimming with great vigour and rapidity, and with great exertion of the arms and legs, may determine its occurrence. These conditions ought, therefore, to be avoided; and, in particular, *none should suddenly plunge into cold water while the body is unduly heated.*

A person seized with cramp, who has been taken out of the water, should be placed in warm blankets, surrounded by warm bottles, and rubbed. A most useful treatment would be to place him at once wholly in a bath of warm water, the head only being supported out of the water.

3. **Writer's Cramp** affects those whose business compels them to write continuously for many hours. Whenever the person engages in writing, spasm of the muscles being used comes on, causing jerky movements or stopping motion altogether. It is probably due to over-exertion and fatigue of the muscles. Pianists sometimes suffer from a similar affection of the muscles used in their vocation, **Pianist's Cramp.** Absolute rest from the habitual motions is necessary. Tonic treatment, friction to the part with liniments, and the use of electricity have benefited, but the disease is very intractable.

4. **Stiff-neck** is the commonest example of cramp. It is partly rheumatic and partly inflammatory, and is commonly due to cold. The application of hot cloths and the use of gentle rubbing will probably be sufficient to relieve it.

5. **Wry-neck** is usually caused by spasm of the sterno-mastoid muscle of one side, by which the head is pulled down to that side and turned so that the face and chin are directed to the opposite shoulder. If it is due to inflammation, heat and pain will be present. In acute cases purgative medicines should be given, and hot poultices or cloths should be applied over the muscle, the person lying at rest. Good diet and tonic medicines are also required. In chronic cases a weak constant current of electricity passed through the muscle is of value. Division of the muscle is sometimes the only cure.

DISEASES OF TENDONS AND BURSÆ.

1. **Simple Inflammation** is liable to attack tendons as the result of a sprain, or owing to gout or rheumatism, their synovial sheaths being also attacked.

The disease may be manifested only by wearing rheumatic pains, accompanied, in some cases, by a creaking feeling when the tendons are moved by contractions of the muscles. In more acute forms, and specially as the result of injury, considerable swelling may occur.

Rest to the part and rubbing will do much to relieve the patient. In the acute cases warm fomentations should be employed.

2. **Whitlow** is a very severe form of inflammation which attacks usually the tendons and their sheaths of the fingers and hand. It begins near the point of the finger in front, which is exquisitely tender, red, swollen, and hard. The pain, which is severe and throbbing, spreads often up the arm to the shoulder. The inflammation may run rapidly along the finger in the tendinous sheath, specially if matter forms in the sheath and cannot get a way of escape externally. If it is allowed to progress the whole

hand, and even the forearm, may become affected, the joints and bones also being seriously imperilled.

Treatment.—Brisk purgatives of salts or seidlitz should be given to the patient, and leeches followed by hot fomentations applied to the part, the hand being kept at rest in an elevated position. If this is not sufficient a free opening along the centre of the finger, to let matter escape and to relieve the severe tension of the parts, is demanded. It sometimes requires most energetic steps on the part of a skilled surgeon to save the finger, and sometimes to save life, which an aggravated case will occasionally threaten. Disfiguration often results. The patient's strength requires to be properly supported by foods and tonics of bark, iron, &c.

3. **Ganglion** (Scotch, *lippen sinen*) is a swelling at some place in the course of a tendon, due to irritation of the sheath of the tendon, and the consequent outpouring into the sheath of more than the usual amount of lubricating fluid. As a result there is formed a small, firm, and movable swelling, which grows slowly, and is found to contain a firm, clear, jelly-like substance, originally fluid. The swelling is most common on the back of the wrist, and less frequently on the back of the foot. Occasionally bodies like melon or rice seeds are formed in the sac from the inflammatory deposit.

The proper **treatment** is either to burst the tumour by pressure and squeeze out the gelatinous substance or to open the sac with a knife. A rough but efficacious method of treating ganglion of the wrist is to cause the patient to lay his hand on the knee of the person who is going to burst the ganglion. Cover the hand with a towel. Then let the operator take a heavy book and bring it down heavily upon the hand. This will burst the sac. After removal of its contents pressure should be exerted on the sac to prevent the return of the swelling. The hard top from the cork of a lemonade bottle rolled in a small piece of lint and bandaged firmly over the part is a simple way of effecting this. Painting with iodine is used for the same purpose, or a small blister may be applied.

4. **Enlargement of Bursæ,** separate from the synovial sheaths of tendons, may occur. It has been pointed out (p. 75) that bursæ are synovial sacs that occur between bony prominences and the skin to prevent undue pressure, and the sacs over and under the knee-pan have been referred to. The bursa in front of the knee-pan is particularly liable to swelling in those who kneel much, and forms

Housemaid's Knee. Signs.—It may be an acute disease accompanied by severe pain, much swelling, and inability to move the joint. As a result of the inflammation matter may be formed and an abscess developed. In the chronic form permanent swelling, through the fluid not being absorbed, and stiffness may be the only trouble.

Housemaid's knee is to be distinguished from inflammation and dropsy of the knee-joint by the fact that when the disease is in the joint the knee-pan is forced forwards and can easily be felt under the skin, while in housemaid's knee it is the sac *in front of* the knee-pan, not the joint, that is affected, and the knee-pan is therefore masked, and cannot be felt owing to the swelling in front of it.

Treatment.—The acute form demands rest, a pillow being placed under the joint to support it. In the early stages leeches will relieve the inflammation, and later hot cloths or poultices are valuable. To aid in reducing the inflammation a purgative of salts or seidlitz should be given to the patient. If an abscess forms it ought to be opened to let the matter escape, and the wound ought to be dressed afterwards with carbolic lotion (one of acid to 30 of water), a small pledget of lint, soaked in the lotion, being thrust between the lips of the wound to permit free escape to any matter that may form later. When the affection is chronic blisters, iodine paint, and firm but regular pressure with bandages are employed, while attention must be directed to the patient's general health.

Miner's Elbow.—A similar affection, from pressure or injury, may attack the bursa over the point of the elbow, or the bursa which lies between the prominence of the hip-bone, that supports the body in the sitting posture and the muscles above it. The swelling over the point of the elbow is often seen in miners, and is therefore called **miner's elbow.**

The treatment is the same for all.

5. **Bunion** is an inflammation and enlargement of the bursa at the side and in the neighbourhood of the ball of the great toe. The irritation is frequently so severe as to cause contraction of the muscles attached to the toe, producing displacement and deformity. The irritation, if aggravated by the pressure of badly made boots, may be so severe and long-continued as to produce disease of the joint and bone.

Treatment.—First of all let properly-made boots be obtained, boots with sufficient room for the toes and forepart of the foot. Then place a soft pad of cotton between the great toe and the one next it, should the great toe have been forced under its neighbour.

Soothe the irritated bursa by rest and hot applications, and, finally, let a bunion plaster be worn to protect the bursa from pressure. The bunion plaster is made of a pad of cotton wool, with a hole in the centre large enough to admit the bunion. The pad is attached to an oval piece of adhesive plaster, by means of which it is fixed to the side of the toe. The plasters may be obtained from druggists.

INJURIES OF MUSCLE AND TENDON.

Rupture or tear of muscle or tendon is due to violent muscular contractions. The muscles most liable are the large muscle of the calf of the leg (*gastrocnemius*), the *biceps* of the arm, and the straight (*rectus*) muscle of the thigh that joins the knee-pan. The tendons give way more frequently, particularly the *tendo Achillis* attached to the heel, and the tendons that bend the wrist.

The **symptoms** are sudden pain at the place of tear, accompanied often by an audible snap, and loss of power over the tendon. The fingers may detect the hollow at the seat of rupture.

Treatment.—The ends of the ruptured muscular fibre or tendon are reunited by a process of repair, by which a new tissue is formed between them. In order to permit this to take place rest is absolutely necessary; and to permit the ends to be brought as near to one another as possible that part should be fixed so that the injured muscle or tendon is relaxed. Thus, let the knee be kept bent when the calf of the leg or tendo Achillis is involved; let the leg be raised and straightened as for fractured knee-pan when the rectus muscle of the thigh is injured. If the biceps of the arm be ruptured bend the elbow, and so on.

Retain the part in its proper position by padded splints and bandages for three or four weeks. After that let the joints of the injured limb be gently exercised, and let great care be taken for a considerable time to prevent renewed rupture or stretching of the new tissue which joins the severed ends.

Sprain is violent stretching of tendon or ligaments of joints, and is often accompanied by partial tearing. The ankle-joint is often affected by the foot being caused to double up under the person.

Symptoms.—There is pain on moving the part, swelling, greater or less according to the degree of injury, and perhaps discoloration. If it be not attended to severe inflammation may arise and fever ensue, especially if a joint is affected. After the inflammation and pain have passed off some degree of stiffness will remain and weakness may be permanent.

Treatment.—Absolute rest is necessary. If the knee or ankle joints be affected splints ought to be applied to maintain rest. In the case of the knee the splint should be behind; but if inflammation ensues the easiest position will be found to be with the knee slightly bent and supported on a pillow. Warm fomentations should be applied. If the pain and heat are great leeches are valuable. When all inflammation has passed let the joints be gently exercised by hand and rubbed with a liniment of soap and opium. Good will also be derived from the employment of the hot and cold douche alternately. For some time afterwards the limb must not be too freely used lest the swelling and pain return.

SECTION IV.—ORGANS OF MOTION AND LOCOMOTION.

A.—THEIR PHYSIOLOGY (FUNCTIONS).

Levers—
Their Classes and Illustrations in the Body.
Standing.
Walking.
Running.

The active agents of movement in the body are the muscles, which, by their contraction, cause the bones to move one on the other, the motion being permitted owing to the union of bones to one another being accomplished through the medium of joints. Of course if all the bones were *rigidly* connected with one another all movements would be impossible.

Now, the muscles, bones, and joints are related to one another in different ways in order to make the movements more effective for different purposes. The bones form *levers*, the attached muscles supplying the *power* for moving them, the joints being the *fulcrum*, or point of support, while the *resistance* is supplied by the weight of the limb, the weight to be lifted or the force to be overcome. In mechanics there are three orders of levers described, according to the relative positions of power, fulcrum, and resistance; and it is found that all the movements of bones on one another can be referred to one or other of the three classes of levers.

Fig. 70 shows a **lever of the first class**, where the fulcrum (F) is between the weight to be lifted (W) and the power (P). There are several examples of this kind of lever in the human body. The head supported on the atlas is a good example. The joint between atlas and skull (p. 21) is the fulcrum, the resistance is the weight due to the part of the head and face in front of the joint, which tend to produce falling down of the chin on the chest, and the power is behind, where the muscles from the neck are attached to the back of the skull. The effect of this particular arrangement is to keep the head steady, balanced on the back-bone, and it is easily seen how well adapted this kind of lever is for such a balancing purpose. It is therefore called the **lever of stability**. The back-bone is balanced on the haunch-bones, and the leg is balanced on the foot by a similar arrangement, the hip-joint in the former case, and the ankle-joint in the latter, being fulcrum. This lever is also used in the body more directly to effect movement. When the forearm is straightened on the arm the elbow-joint is fulcrum, the power is supplied by the triceps muscle *behind*, and the resistance is the weight of the forearm *in front* of the fulcrum (Fig. 71).

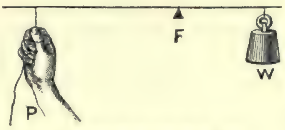


Fig. 70.—Lever of the First Class.

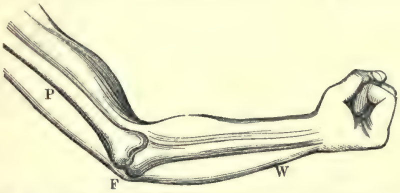


Fig. 71.—Lever of the First Order, illustrated by straightening of the Elbow-joint.

In **levers of the second class** the weight is between the power and fulcrum (Fig. 72). It is not common in the body. Standing on tiptoe, however, is an example. The fulcrum is afforded by the toes, in contact with the ground; the power is the action of the muscles of the calf, and between these is the weight of the body transmitted down the bones of the leg to the foot (Fig. 73).

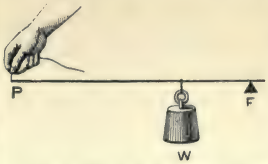


Fig. 72.—Lever of the Second Class.

In levers the force exerted is always proportional to the distance between the fulcrum and the point of application of the force. Now, in levers of the second order the distance between the power and the fulcrum — called the power arm—is greater than the distance between the weight and the fulcrum—the weight arm. So that a force acting through the greater distance between the power and fulcrum would be able to *overcome* the same force acting through the smaller distance between the weight and fulcrum, just because, though the forces were the same, the power arm was longer than the resistance arm. In other words, a smaller power would be able to overcome a larger resistance, because of its greater distance from the fulcrum. This lever is therefore called the **lever of power.** This lever has the disadvantage that the power must always move through a greater distance than the weight.

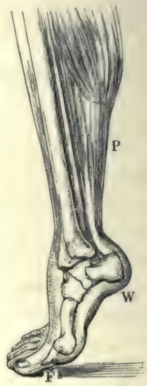


Fig. 73.—Lever of Second Order, illustrated by standing on tiptoe.

In **levers of the third class** the power is between the weight and the fulcrum (Fig. 74). It is common in the human body. In bending the forearm on the arm the power is supplied by the biceps muscle attached to the radius, the fulcrum is the joint at one end of the lever, and the weight is at the other end—the weight of the forearm.

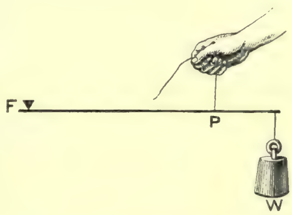


Fig. 74.—Lever of the Third Order.

It will be remembered that at the elbow-joint

an illustration of a lever of the first order also is afforded *in the extension* of the joint by the triceps muscle.

This is the **lever of rapidity,** for it will be observed that a small movement of the biceps will produce considerable movement of the hand. It is, however, a lever that loses power, for, unlike the last case, here the weight arm is long and the power arm short.

In all the movements of the body these mechanical arrangements are exhibited.

Standing in the erect posture is the position which requires least muscular exertion, the different curves of the back-bone aiding in balancing the trunk, and the various joints being so constructed that only a certain amount of steadying action is required on the part of the muscles, the muscles of the calf, for instance, preventing the falling forward of the leg. In the erect posture, too, the body fulfils the necessary condition of having its centre of gravity within its base of support. Thus, a line dropped from the centre of gravity, which is in front of the sacrum, would fall between the feet a little way in front of the ankle-joints.

In **walking** the weight of the body is supported alternately by one limb and then the other, being hardly balanced on one limb before it is thrown to the other. At the moment when the advanced foot has reached the ground the muscles of the calf of the leg behind contract and raise the body on the ball of the toes (Fig. 73), thrusting it forwards and to the side. The weight of the body is thus thrown on the advanced leg, and, owing to the forward movement, the leg that is behind swings forwards like a pendulum, and now becomes the advanced leg, and so the process goes on.

In **running** there is a short period when both feet are off the ground. Running differs from walking also in the quick violent contractions of the muscles, and in the fact that the advance is due to muscular effort alone, and therefore there is proportionately a much greater expenditure of force than in walking.

Thus motion and locomotion are dependent upon mechanical relations subsisting between muscles, bones, and joints. When these relations are interfered with there is difficulty of movement greater or less, according to the amount of the interference, as will be seen by considering the diseases of movement in the following part of this section.

SECTION IV.—ORGANS OF MOTION AND LOCOMOTION.

B.—THEIR DISEASES.

Rigidity:—*Anchylosis*—*Contracted Muscles or Tendons.*
Deformities:—*Club-foot*—talipes varus, valgus, equinus, calcaneus;
Flat-foot;
Knock-knee;
Bow-legs;
Clubbed Hands;
Supernumerary Fingers and Toes.

Rigidity or Stiffness of Joints.

It has been pointed out that a joint usually acts as the fulcrum or fixed point from which the bony lever operates when moved by muscular contraction. If, therefore, from any cause the joint has become so stiff as to be immovable the function of the parts is destroyed. Now, the stiffness may either be due to disease of the joint itself, or it may be caused by fixture of the joint, by contracted muscles or tendons in its neighbourhood.

Anchylosis (from Greek *ankulos*, crooked) is the term applied to rigidity that has resulted usually from inflammatory disease of the joint. It may occur, without inflammation, in a joint which has been kept in one position for a long time, and in old age it occurs as a natural process in certain of the smaller joints. Anchylosis has been divided into *true* or *false*, or *complete* and *incomplete*. **True anchylosis,** or stiffness or immobility of the joint, is said to exist when the gristle of the joint is destroyed and the heads of the bones are connected or consolidated together by osseous or bony matter (p. 32). **False anchylosis** is where the process falls short of ossification, the stiffness and immobility depending not on bony union of the connecting surfaces, but either upon adhesions of

the synovial membrane or upon a thickening of the parts about the joint.

When the gristle of a joint has been destroyed by ulceration, and the surfaces of bone exposed, anchylosis, or a bony union, is the most favourable termination that can take place. In such a case care should be taken that the joint becomes fixed in the position in which it will be most useful to the patient. Thus, if it be the hip or knee, the straight position will be best, if the elbow, it should be placed at a right angle. Again, in scrofulous ulceration of the spine, anchylosis is a most favourable result, because as soon as the bony union is formed the morbid or diseased process is ended, and it is the completion of the cure. Thus in hip-joint disease, white swelling, and scrofulous diseases of the spine, anchylosis is often to be regarded as a favourable issue.

Anchylosis, however, in fractures near the joints, should always be prevented if possible; and for this purpose, gentle motion of the joint ought to be had recourse to before it is too late, as directed in the section on Fractures.

In cases of *incomplete anchylosis*, where the stiffness only arises from thickening of the parts, much relief may be derived from the use of steam, by placing the stiff joint over the steam of boiling water, at such a distance as to prevent scalding, then drying the part, and rubbing it with neat's-foot or cod-liver oil, or the compound soap liniment, or goose fat. By perseverance in this plan of treatment complete restoration of function may be obtained. Cold applications, such as holding the part below a rush of water, or pouring water from a teakettle, have likewise been employed; and when the patient has arrived at middle life, this may be used twice a day, and the part dried, and some of the above liniments rubbed on. The flow of cold water should, however, not be used longer than three or four minutes, as no good will be effected unless a glow of heat is felt in the part after it has been dried.

Surgeons now practise an operation for breaking up the adhesions in cases of false anchylosis, and so restoring the natural movements of the joint.

Contracted Muscles or Tendons may render a joint immovable. Sometimes the contraction of a muscle is *spasmodic*, as in spasmodic wry-neck, discussed in the last section. In other cases the contraction of one set of muscles is *due to paralysis of the opposing set.* Thus suppose, as in some cases in children due to a nervous affection, that the muscles in front that straighten the leg on the knee have become paralyzed, the flexor or hamstring muscles behind will have it all their own way, and will keep the knee bent, so that the child cannot of its own will extend the leg. *Early in the disease*, however, a person taking the child's leg in his hand will be able easily to straighten it; but as soon as he lets it go it will spring back to its bent position. When the disease has *become confirmed* the flexor muscles tend to become permanently rigid in their shortened condition, the child never being able to put them on the stretch by straightening the leg. So that, after a time, neither the child nor another person can extend the leg, which remains fixed in its distorted position.

Such deformities of limbs are of not infrequent occurrence in children, and many, if not the most of them, are easily rectified *if early attended to.* It is difficult sometimes to say whether the deformity is due simply to *spasm* of one muscle or set of muscles, or to *paralysis* of one set, and consequent shortening of the opposing muscles. The advice of a skilled surgeon should, therefore, be sought to determine this as well as the treatment; for in some cases cutting of the rigid muscles will be necessary, while in others the remedy is to be sought for rather in restoring power to the paralyzed muscles.

The commonest examples of contracted muscles and tendons are seen in

Club-foot *and other similar Deformities.*

Club-foot, the scientific name of which is **Talipes,** is a deformity of the foot due to shortening and stiffness of certain muscles and tendons, and accompanying alterations in the position of the tarsal bones and in the form of their joints. Owing to the deformity the person cannot put the foot down on the ground in the usual way, resting on the sole. The foot is so twisted that the person walks on the outside edge of the foot, or on the inside edge, on the heel only or toes only. There are thus several varieties of club-foot, according to the way in which the foot is twisted.

Four general forms are described: (1) in which the *outer* edge rests more or less on the ground, the inner edge being turned upwards—**talipes varus**; (2), in which the *inner* edge rests on the ground, the reverse of (1)—**talipes valgus**; (3), in which the heel is raised and only the toes touch the ground, called **talipes equinus** (Latin *equus*, a horse), because of its resemblance to a horse's hoof; and (4), in which the reverse is the position, the front portion of the foot being

raised, and only the heel reaching the ground—**talipes calcaneus.** Besides these there may be other kinds in which there is a combination of two of the different forms described. All of these forms of club-foot may be *congenital*, that is, the child may be born with the deformity, or *acquired*, that is, the affection may be developed after birth. In both cases the disease may be caused by *paralysis* of muscles or by *spasm.* Thus take the case of club-foot where the outside of the foot is turned down and the inside up. On referring to the section on the Muscles it will be seen that the muscles that pass from the leg to the outer side of the foot are the peroneals, and that they raise the outer side, while on the inner side the foot is raised by the tibialis anticus. Suppose the peroneal muscles become paralyzed, then the foot cannot be raised on the outer side, and there is nothing to oppose the action of the tibialis anticus, which accordingly pulls up the inner side, and so the deformity is produced. But again the tibialis muscle may become spasmodically contracted, and by the force of its spasm overcome the action of the healthy peroneal muscles, and so turn the inside of the foot up, producing a like deformity. Similar causes are at work in the production of the other kinds of club-foot.

Fig. 75.—Talipes.
1 and 2, Equinus; 3 and 4, Varus; 5 and 6, Valgus; 7, Calcaneus.

Treatment.—Much may be lost by neglect to seek the advice of a surgeon in cases of club-foot, for, if attended to early, many cases can be completely cured. It is only necessary here to indicate the lines on which treatment proceeds, for, while none but skilled surgeons can decide what should be done in a particular case, mothers and nurses who have some sort of understanding of what is required can do much to aid the cure. Obviously if the deformity be due to paralysis, as in most cases it seems to be, restoring the power of the enfeebled muscles will be the main thing. This is effected by rubbing, kneading the muscles, stimulating them by electricity, and so on. If, on taking the foot in the hand, its natural position can be restored by gentle force, and, on removal of the pressure, the foot springs back to its unusual position, the case is probably one of paralysis. In such a case, then, let the mother or nurse take the foot in the hand, and gently and gradually bring it back to its proper position, retaining it there for a little time. It may not, at first, be possible to bring it quite straight. Let the process be repeated often, but only for a few minutes each time, the muscles on the outside of the leg being stroked and handled frequently. It will be found that the foot in time can be made quite straight with ease. After a time, if the foot be not too tender, some apparatus may be adopted for the purpose of supporting the foot in the proper position. For instance, a boot, with some elastic support passing between the outer side and the knee, would suit the purpose. As the foot gradually yielded, the elastic support could be tightened till the proper position had been restored.

When the deformity is due to stiffness and shortening of muscles, the offending muscles require to be divided first, and manipulation used afterwards.

The reason why no time should be lost in attending to a case of club-foot is that, in a paralytic case, the healthy muscles, which, by being unopposed, draw the foot up, will in time become shortened and stiff and then the case is aggravated. A second reason is, that the bones and joints get in time affected, altered, and render the cure much more difficult.

Flat-foot is a deformity akin to the second variety of club-foot. The foot loses its arch, and rests on its inner side. Pain and difficulty are experienced in walking, because the small bones of the foot have lost the proper relation to one another, owing to absence of the arch.

Treatment consists in placing a pad inside the boot, so as to support the inner side of the foot and restore the arch. To the inner side of the boot an elastic support may be supplied by india-rubber bands running up to and attached by a metal band round the knee. At the same time friction should be used to the weak muscles of the inside of the leg.

Knock-knee (*In-knee, Calf-knee, Genu-Vulgum*) is due, like flat-foot, to yielding of the liga-

ments and muscles round the joint. The knee is bent inwards at the joint. It is due to weakness, and is common in badly reared children, who are ill fed and live in a bad atmosphere in confined dwellings. Sometimes it occurs in children even before they have begun to walk; sometimes it arises in growing boys about twelve years of age, as the result of undue exercise, or fatigue in walking or standing, and living in a poisoned atmosphere.

The **treatment** should therefore first of all be directed to the nourishment of the child. To restore the natural position of the parts, when the child is lying the legs should be straightened, a pad put between the knees, and the ankles approached to one another by a bandage. For walking, an apparatus may be worn. A suitable one consists of a belt of steel round the hips, from each side of which a rod passes down the outside of the leg to be fixed in the outer side of the shoe. The rod should be of steel, bent outwards, and jointed at the knee. Opposite the knee-joint a broad elastic band should pass round the knee and be secured to the rod, so as to keep the knee from bending inwards. A bandage should also be similarly adapted in the middle of the thigh and in the middle of the leg. The apparatus must be used for many months before the cure is nearly complete. Care must be taken that the knee-joint is not allowed to become stiff through wearing the apparatus.

Bow-legs consist in a bending of the legs outwards, and are usually the result of a soft condition of the bone as in rickets. In such a case adopt the treatment for rickets (p. 30). Mechanical contrivances similar to that described above, are in use for this affection also, though they are valuable mainly before the bones are quite firm.

Clubbed Hands are a rare defect; and the principles of their treatment are the same as those for club-foot.

Fingers may be drawn down towards the palm and there fixed by shortening of the tendons. This may have been due to burns of the palm of the hand and the contraction in healing, or it may have been caused by inflammation in the sheath of the tendon.

Rubbing and manipulation may do a great deal of good; often division of the tendon is required. To prevent contraction of the fingers during healing of a wound or burn, the finger should be kept straight by a splint.

Supernumerary Fingers and Toes are extra fingers and toes, often not properly developed, with which children are sometimes born. This deformity is frequently hereditary. The extra fingers or toes can easily be removed by a surgeon if necessary. Their possession has sometimes been known to cause such mental distress and vexation to sensitive girls, as to lead to convulsions and frequent attacks of fits like epilepsy, a mere allusion to the deformity being sufficient to bring on a hysterical attack. On the removal of the annoyance by an operation, the tendency to fits has often completely disappeared.

SECTION V.—THE NERVOUS SYSTEM.

A.—ITS ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

Nerve Cells and Fibres:—Their *microscopical structure.*
Their *association* in nerve-centres, nerves, and ganglia. Their *functions.*
Nervous Action:—*Reflex action.*
The Cerebro-spinal System.
The Brain:—Its division into *Cerebrum, Corpora Striata, Optic Thalami, Corpora Quadrigemina,* and *Cerebellum*;
Its *peduncles, ventricles,* and *membranes*;
Its *microscopical structure,* blood-supply, size, and weight.
The Spinal Cord:—Its *structure.*
The Functions of the Central Nervous System.
The Functions of the Spinal Cord and Spinal Nerves.
Connections between the Brain and Spinal Cord.
Functions of the Various Parts of the Brain—Cerebral Hemispheres, Corpora Striata, Optic Thalami, Corpora Quadrigemina, Pons Varolii, Cerebral Peduncles, Cerebellum, and Medulla.
Localization of Function in the Brain. Phrenology.
The Cranial or Cerebral Nerves. The Sympathetic System of Nerves. The Distribution of Nerves.

No matter how complicated a nervous structure, such as that of man may appear to be, it is found to consist essentially of two, and only two, elements, **nerve-cells** and **nerve-fibres.**

The cells and fibres are combined and associated in various ways and are embedded in and supported by fine connective tissue so as to form a connected structure. The nervous tissue so formed is protected by membranes, and receives a rich supply of blood for its continued nourishment and growth, channels also being provided for the removal of its waste substances.

Nerve-cells have a general resemblance under the microscope to other cells. They vary in size from $\frac{1}{5000}$ to $\frac{1}{400}$ of an inch. They consist of masses of granular-looking material—protoplasm—and contain a nucleus and nucleolus (see CELLS, p. 15), but have no cell wall. Processes or poles pass from the corpuscle or cell, branching outwards. There are various kinds of nerve corpuscles, the main differences being in the shape of the cells, and in the number of processes given off from them. Some

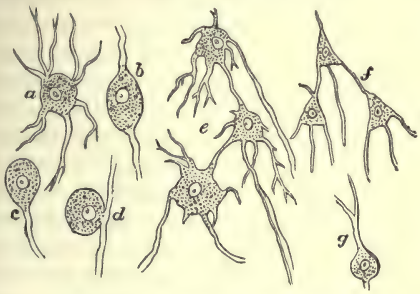


Fig. 76.—Various Forms of Nerve-cells.

cells give off two, others many processes. One kind of cell is characteristic of one part of the nervous system. Thus in Fig. 76 *a* and *e* show the appearances of cells found in the spinal marrow. They are large, irregular masses of protoplasm, and give off many poles or processes, and are accordingly called **multipolar**. In the same figure *f* represents three cells from the large brain (cerebrum). They are triangular in shape, and give off a process from each angle, and another from the centre of the base of the cell. They are called **pyramidal nerve-cells** from their shape, and sometimes **tripolar**, that is, with three poles, though, as we see, they may have four poles. *c* and *g* show cells from the lesser brain (cerebellum). They are rather oval in shape, and one or two branching processes come off from the small end of the oval. Those with one process are called **unipolar**, those with two **dipolar**. So characteristic are these forms of cells of special parts of the nervous system, that under the microscope a small piece of spinal marrow could be identified, simply by the presence in it of a multipolar cell, and a small piece of large brain simply by the presence of a pyramidal cell; and so on.

The processes of cells become important parts of nerve-fibres, as will be seen in considering nerve-fibres. Nerve-cells grow, manifest activity, and decay as do other cells (p. 15).

Nerve-fibres present the appearances shown in Fig. 77, *c* and *d*. They are of glassy transparency, and have a double outline as represented in the figure. They thus resemble tubes. The contents of the tube are of a clear jelly-like character. When stained by colouring agents nerve-fibres are found to consist of a rod passing down the centre, called the **axis-cylinder**, which is surrounded on all sides by a white substance, the **white substance of Schwann**, the whole being inclosed in a delicate sheath (**neurilemma**). At intervals gaps occur in the white substance, but the central core is continuous throughout the whole length of the nerve. In *a* and *b*, Fig. 77, the gaps in the white substance, which is as if stained black, are shown, and the axis-cylinder is seen crossing the gap. In some fibres (*e* of Fig. 77) no white substance exists, but only the central rod surrounded by the delicate sheath. A nerve-fibre resembles a wire prepared for conducting electricity, with its central rod of copper and its outer layer of gutta-percha, silk, or cotton, to coat the copper and protect it from contact with other conductors. The copper rod is the important part of an electrical conductor. Similarly the axis-cylinder is the important part of a nerve-fibre, and *it is found to be the continuation of a process of a nerve-cell.* Thus nerve-cells and nerve-fibres are related in that the process of one is the axis-cylinder and essential part of the other.

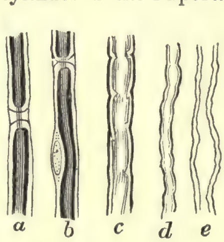


Fig. 77.—Nerve-fibres.

Nerve-cells are frequently collected into groups, the various cells of the group communicating with one another. This is called a **nerve-centre**.

Nerve-fibres are associated together in bundles, the bundle being supported and surrounded by connective issue, and thus a **nerve** is formed.

Ganglia is the term applied to distinct and separate little masses of nerve-cells associated with the fibres related to them.

The Functions of nerve cells and fibres are different. The cell is a highly active mass

of living material; and it draws nourishment from the blood, supplied to it in abundance. That nourishment not only keeps the cell living, but is to be considered as raw material which the cell works up so as to derive from it force or energy. The cell is thus a little manufactory, deriving its raw material from the blood, and developing from it nervous energy. The nerve-fibre, again, is the conductor of the nervous activity; it affords the pathway along which the energy generated by the cell may be discharged. Of course the nerve-fibre, consisting, as it does, of living nervous substance, is also capable of generating energy, but its special function is to conduct influences to or from the cells.

Nervous Action. — It has been seen that nerve-fibres are in connection with nerve-cells, and that the fibres conduct the energy developed in the cell; and so the question arises, "Whither is the energy conducted, to what place does it proceed?" Well, in highly developed creatures like the higher animals and man, nerves proceed to nearly every tissue and organ of the body. They go to muscles and enter even into their very fibres; they are found in the coats of blood-vessels; they have recently been shown to be intimately connected with the cells of glands; they ramify through the skin; they are among the chief parts of the structure of the organs of sense. The activity sent to a muscle reveals itself in the contraction of the muscle, in movement; the activity sent to a gland produces increased action of the gland, increased flow of the gland secretion, the fluid prepared by the gland. Thus it is the organ at the end of the nerve—**the terminal organ**, as it is called—and not the nerve-cell or the nerve-fibre that determines the mode in which the nerve-impulse shall display itself. Nerves that proceed to muscles are called **excito-motor** because the activity they conduct leads to motion; those that go to glands are called **excito-secretory**, because they excite to secretion; those that are found in the walls of blood-vessels are called **vaso-motor**, because they excite changes in the capacity of the vessels, make them wide or narrow, by causing the muscular tissue in their walls to contract or become relaxed; and there are others that are called **sensory**, for a reason that will be explained immediately. These names, as we have seen, are founded on a mistake, because it is not the fibre that determines motion, or secretion, or sensation, but the organ in which it ends, the terminal organ.

Another question arises, namely, When or why does nervous activity display itself; what causes a nerve-cell or a group of them to discharge its energy along a nerve, so that movement or some other effect is produced? The cause is called a **stimulus**, or an **excitation.** For example, a barrel of gunpowder is a store of energy, but the energy is quiet, latent, confined, and cannot reveal itself until it has been liberated. Apply a lighted match to the barrel: the match excites the powder, causing it at once to liberate and discharge its energy. The lighted match was the stimulus to the gunpowder. So nerve cells and fibres require a stimulus before they will discharge or transmit their energy. Nerve structures may be stimulated *mechanically*, by pinching or pricking. They may be stimulated *chemically*; for example something sour taken into the mouth causes at once a great flow of fluid—saliva—into the mouth, because the nerve supplying the salivary glands has been stimulated by the acid substance. Again nervous structures may be stimulated *electrically*. Every one knows that if he takes into his hands the handles of a moderately strong electrical coil, his fingers close over the handles of the instrument, and though he desire it ever so much he cannot let go. That is because the electricity has stimulated the muscles, directly no doubt, but also through their nerves, to contract, and, so long as the stimulus continues, his muscles remain contracted, thus keeping his hands closed. *Heat* also will stimulate nerves. Now nerve-cells may be stimulated *directly*, that is, the stimulus may be applied to them. Usually, however, it is a nerve that is irritated first. The nerve conducts the *impression*, which it has received, to the nerve-cells; and they, in turn, are stimulated, and discharge their energy along other nerves to muscles, glands, or other structures, as the case may be. There is thus a chain of events following the irritation of the nerve, and to the completed process a term of great importance in nervous physiology is applied, namely, **reflex action.**

Fig. 78 will render the meaning of this phrase more easily understood. In the figure, B is a nerve-cell. Leading to it is a nerve A coming from (1) some sensitive surface, say the skin. Connected with the nerve-cell is another nerve C, which passes to a muscle (2). Suppose something (a prick, sting, &c.) irritates the surface (1), immediately an impression is transmitted along the nerve A to the nerve-cell B. The cell receives the impression, is stimulated by it, and is thus caused to discharge its

activity along the nerve C to the muscle (2), leading the muscle to contract. This is a simple reflex action, but there may be many much more complicated, in which there may be involved many cells and nerves, and many muscles or blood-vessels or glands, &c. The nerve A leading inwards to the cell is called a **sensory** nerve because it conveys the irritation that has been made on the surface. But sensory is not a good word, because no sensation or feeling need result. A better word is, therefore, **afferent** (*ad*, to and *fero*, I carry), meaning carrying *to* the centre. Similarly the nerve C may be called **efferent** (*e* or *ex*, from, and *fero*, I carry), carrying *from* the centre. Many of the movements and actions of our daily life are nothing more than complicated reflex actions. It is to be noted that such actions may occur without effort of will, and even without our being conscious of them. For example, tickle the sole of the foot of a sleeping man. He withdraws his foot, being at the time sound asleep and totally unconscious. This is a reflex act. The tickling has irritated some nerves of the skin; an impression has been transmitted along nerves upwards to nerve-cells in the spinal marrow. These nerve-cells, being stimulated, have discharged their energy along nerves proceeding to the muscles of the man's leg, the muscles have responded by contracting, and the leg has been moved. All this may have happened without sensation on the man's part, the nerve-centres involved in the action being in the spinal marrow. It is only when the impression reaches the brain by travelling up the spinal marrow that sensation or feeling can arise.

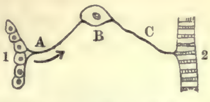


Fig. 78.—Reflex Action.

In warm-blooded animals, such as man, a nervous impression has been calculated to pass along a nerve at the rate of about 200 feet per second.

Nerve-energy is the energy or activity already alluded to as the chief object of the nerve-cell to create, and the nerve-fibre to conduct. Nerve-energy is one and the same thing in whatever part of the body produced. Ideas are as much the expressions of nerve-energy as the contraction of a muscle or the activity of a gland. But how nerve-energy is transformed into thought, or is the agent in the production of thought, or what is the kind of intermediate apparatus it stimulates to produce thought, all this we do not understand—perhaps never will. Nevertheless, a man whose nerve-energy is exhausted is as incapable of good intellectual activity as of good physical labour. Nerve-energy is produced by nerve-cells, and the nerve-cells manufacture it, so to speak, from the blood. In other words, their activity depends on the blood-supply they receive, and naturally, not only on the quantity but also on the quality of the blood. Now the blood is nourished by the food taken. Other things being equal, by a proper quantity of food of the right sort, taken at proper intervals, the blood will be maintained in strength and purity, and will, therefore, be fit nourishment for the nerve-cells, as for other tissues of the body. It is necessary that this nourishment should be constantly renewed, because nerve-energy as well as the other forces of the body are being continually used up by the daily work of life. The nerve-cells will produce increased nerve-energy on the stimulus of a demand, but to meet the demand they must, in turn, be supplied with increased nourishment. Now suppose a man worried by business, neglecting to take his food at regular times, and consuming it hurriedly to return to business again, he is really using an increased quantity of nerve-energy, but allowing for the increased demand a *diminished* supply. The effects are naturally nervous exhaustion and nervous irritability, for nerves become more irritable as they become exhausted. This is all plain, and people can be got easily to recognize it and to admit it. But there are means of exhausting nerve-energy other than excess of work and diminution of nourishment—other causes not so willingly acknowledged. Two special causes ought to be observed, the first of which is the taking of stimulants to excess, or the constant use of opium and other similar drugs. The other form of excess is sexual excess, both of a legitimate and of an improper sort.

Without doubt, also, if nerve-cells were not being made use of, if there were no demand made on them for energy, they would grow feeble for want of action, degenerate, and finally die altogether. This has very important bearings on questions of training and education, which will be best considered in discussing the structure and functions of the brain.

THE CEREBRO-SPINAL SYSTEM.

It has been said that however complicated a nervous structure may appear to be it consists essentially of nerve-cells and nerve-fibres. One can scarcely believe that the complicated brain

and spinal cord of man consist only of such apparently simple elements. On tracing the development of a nervous system upwards from the lower to the higher animals, however, one becomes reconciled to the idea.

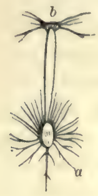


Fig. 79. Nervous System of a Crab.

Fig. 79 shows the nervous system of a crab, consisting of *a* and *b*, little masses—ganglia — of nerve-cells, and fibres issuing from them.

Fig. 80. Nervous System of an Ant.

In Fig. 80, the nervous system of an ant, there is simply a series of these little ganglia, connected by a double chain of fibres, and fibres passing from them. It is found that as one advances up the scale of animal life the number of these ganglia increase; they become larger in size and more closely connected together, until a continuous cord is formed, a cord consisting of a combination of cells and fibres, the ganglia at the head at the same time undergoing special development. Thus there is at last reached a stage in the animal kingdom when a continuous spinal cord is found, and masses of cells and fibres exist in the head as a brain, brain and spinal cord forming what is called a **cerebro-spinal system.** The brain is simply a series of ganglia that have undergone special development. In man the brain has reached its highest development, some of the ganglia being greatly enlarged and overlapping others.

Thus the nervous system of vertebrates, or animals having a backbone, consists of the brain, spinal cord, and nerves. The portion termed the brain proper, or **encephalon,** is situated in the cavity of the skull; the spinal cord lies in the canal formed by the rings of the bones called vertebræ existing in the backbone and united by ligaments. The position of these parts is seen in Fig. 81.

The Brain.

The brain proper consists of the **cerebrum,** or larger brain, which occupies the whole of the upper and front parts of the cavity of the skull, the **cerebellum,** or lesser brain, lying beneath the hinder part of the cerebrum, and the **medulla oblongata,** or oblong marrow, which may be regarded as a continuation of the spinal cord within the cavity of the skull, and as forming the connection between the brain and cord. Included also in the brain are certain masses of nervous matter to be afterwards described, lying towards the floor of the cavity of the skull, covered over and concealed by the larger brain, and called **basal ganglia.**

The cerebrum and cerebellum are almost completely divided into two lateral halves by a deep longitudinal fissure, and the surface of the former is divided by a considerable number of irregular furrows, nearly an inch deep, into **convolutions.** As the gray matter of the brain spread out on its surface is the portion having the highest functions, its quantity is largely increased by being thus thrown into convolutions.

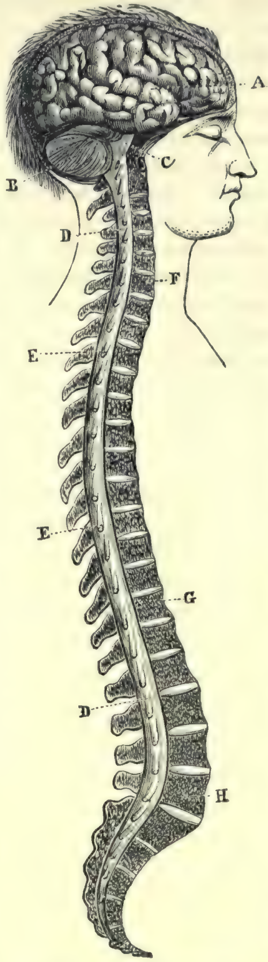


Fig. 81.—Position of Brain and Spinal Cord.

A, Cerebrum, or brain proper. B, Cerebellum. C, Pons Varolii, and below it the medulla oblongata. D D, Spinal marrow, showing the origin of the spinal nerves. E E, Spinous processes of the vertebræ. F, 7th cervical vertebra. G, 12th dorsal vertebra. H, 5th lumbar vertebra. I, Sacrum.

The **Cerebrum** is oval in form, arched above and somewhat flattened on its lower surface, which rests on the floor of the skull. Usually its anterior or frontal portion is somewhat narrower than the hinder portion, and its greatest breadth is between the ears. The great fissure, running from before backwards, divides it into two **hemispheres,** but these are connected by a large band of nervous matter, seen in Fig. 84, B, called the **corpus callosum.** Each hemisphere is divided by anatomists into anterior, middle, and posterior lobes, corresponding generally to the same regions of the skull. The general appearance of the surface of the cerebrum is seen in Fig. 82.

The under surface of the brain (Fig. 83), which rests on the floor of the skull, shows the origins of the important nerves, called the **cranial nerves,** the **cerebellum,** the **optic commissure** (2–2) or structure connecting the optic nerves, the **pons Varolii** (PV) or bridge of nervous matter connecting together the two hemispheres of the cerebellum, and lastly numerous **convolutions.**

If we divide the brain into two portions by cutting lengthwise through the great longitudinal fissure, and dissecting a short way towards either side, we find that each hemisphere covers over several large masses of nervous matter, which have been called the **ganglia at the base of the brain.** These are from before backwards: (1) two bodies streaked on the surface, and hence called **corpora striata,** or striated bodies; (2) two bodies behind and a little to the outer side of the corpora striata, supposed by the older anatomists to be connected with vision, and hence called the **optic thalami,** or optic masses; and (3) four bodies, two on each side, called **corpora quadrigemina,** or twin-like bodies.

All these parts of the brain are connected with each other by numerous nerve-fibres. The fibres from the spinal cord pass upwards in

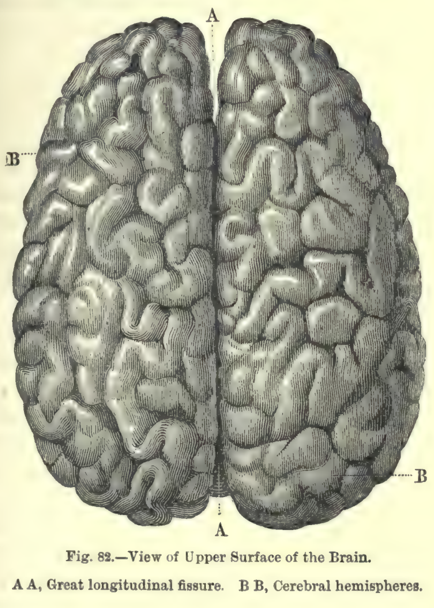


Fig. 82.—View of Upper Surface of the Brain.

A A, Great longitudinal fissure. B B, Cerebral hemispheres.

the medulla oblongata, those from the hinder part going chiefly to the cerebellum, whilst those from the front pass chiefly to the cerebrum. In the cerebrum, cerebellum, and ganglia we also find fibres running from one part to another, as from before backwards and across, so as to unite all the parts of the brain and form one complete organ.

A side view of the brain is seen in Fig. 84, which should be studied with the aid of the description.

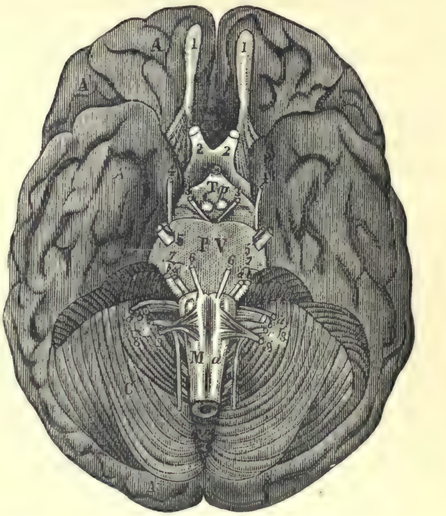


Fig. 83.—View of the Lower Surface of the Brain, showing the beginnings of the Cranial Nerves.

A, Anterior lobe. A′, Fissure of Sylvius. A″, Middle lobe. A‴, Posterior lobe. C, Cerebellum or lesser brain. Ma, Medulla oblongata. PV, Pons Varolii. Tp, The pituitary gland. 1–1, First pair of nerves, or *olfactory* nerves. 2–2, Second pair, or *optic* nerves. 3–3, Third pair, or *common motor nerves* to *muscles of eyeball.* 4–4, Fourth pair, or *pathetic nerves* for one muscle of eyeball. 5–5, Fifth pair, *trifacial* or *trigeminal*, giving sensibility to face, tongue, and teeth, and motion to muscles of mastication. 6–6, Sixth pair, or *abducent* nerves, to external rectus muscle of eyeball. 7–7, Seventh pair, consisting of two portions—*a*, *facial*, giving power of motion to muscles of face, and *b*, *auditory*, or nerve of hearing. 8–8, Eighth pair, consisting of three portions—*a*, *glossopharyngeal*, supplying sensibility to tongue and back of throat, also partially motor; *b*, *pneumogastric*, supplying throat, heart, lungs, and stomach; and *c*, *spinal accessory*, giving motor power to certain muscles of neck. 9–9, Ninth pair, or *hypoglossal*, supplying power of motion to tongue and to several muscles in neck.

The **cerebellum,** or lesser brain, lies in the back part of the skull cavity, and is covered over in man by the hinder lobe of the cerebrum. It is, as it were, slung on the back of the cerebro-spinal axis, and consists of two hemispheres with an intermediate portion, or middle lobe, sometimes called the **vermiform process.** The whole surface of the cerebellum is divided into convolutions by irregularly-shaped furrows passing crosswise.

The cerebrum, cerebellum, and spinal cord are connected together by thick bands of fibres called **peduncles** or **crura.** Thus, connected with the cerebellum, there are three pairs of peduncles, two joining it to the spinal cord below, two to the cerebrum above, and two passing crosswise and forming the **pons Varolii.**

The **ventricles** of the brain are cavities varying in size which exist in different parts. Thus

in each half of the cerebrum there is such a cavity, the **lateral ventricle**. Between the hemispheres of the brain in front is the **fifth ventricle**, and further back the **third ventricle**. A considerable space exists between the back of the medulla oblongata and the under surface of the cerebellum which rests upon it. The space is called the **fourth ventricle** (see Fig. 84), and in its floor are many very important nerve-centres. A small amount of fluid exists in health in these cavities; but in some diseases, such as

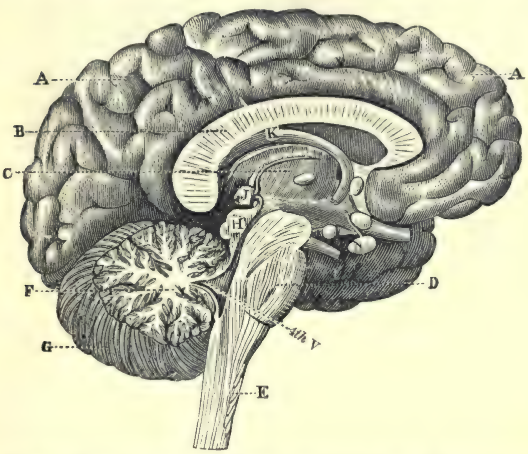


Fig. 84.—View of a Section of the Brain in the Middle Line. The inner aspect of the left side is seen.

A, Plane of the great fissure. B, Corpus callosum. C, Optic thalamus. D, Pons Varolii, under which is seen the medulla oblongata, or cranial portion of the spinal cord. E, spinal cord. F, Section of cerebellum, showing its peculiar leaf-like appearance which has given it the name of "tree of life". G, Left half of the cerebellum, showing convolutions. *4th* V, Fourth ventricle.

"water in the head", the quantity of fluid is enormously increased.

When an incision is made into the brain it is seen to be composed of *white* matter internally, and *gray* matter externally. The white matter is more firm and consistent than the gray matter; indeed, the latter is so soft as to be readily washed away from the brain soon after death by a jet of water. The gray matter forms a layer or web over the surface of the cerebrum and cerebellum, and it also exists in masses at various points in the deeper parts, as for example in the corpus striatum, optic thalamus, corpora quadrigemina, pons, medulla, and cerebellum. The white matter constitutes the greater portion of the internal parts of the brain. As brain substance is too soft and too opaque in the natural condition for microscopical examination with high powers, physiologists have devised methods by which portions may be hardened so that thin sections may be cut. These sections are immersed in dilute solutions of such dyes as carmine or logwood, with the effect of staining certain parts of the structure, and thus rendering them visible. When such sections are properly prepared and mounted for microscopical examination it is found that the white matter in the deeper parts of the brain consists of nerve-fibres bound together by fine connective tissue. The gray matter consists of a very fine variety of connective tissue to which the name *neuroglia* has been given, and in this lie embedded masses of nucleated protoplasm called *nerve-cells*, often having branching processes, as already described (p. 85).

The brain and cord are protected by three **membranes**, named also the **meninges**. These are: (1) a strong outer fibrous membrane named the **dura mater**, which closely lines the interior of the skull and forms a loose sheath in the spinal canal, (2) an inner thin membrane called the **pia mater**, which is closely adapted to the surface of the brain and spinal cord, and, being crowded with blood-vessels, carries to them their blood-supply, and (3) an intermediate membrane, the **arachnoid**, which lies over the pia mater and under the dura mater. The dura mater may be regarded as the protective covering of the brain, and the pia mater as a special membrane on which blood-vessels divide and subdivide, so as to be of very small size before they penetrate the brain; whilst the arachnoid is really a double membrane, one layer being adapted to the dura mater and the other to the pia mater, the space between these occasionally containing a small quantity of fluid. These membranes are sometimes the seat of inflammation.

The brain is very richly supplied with blood. The main arteries enter the base of the brain, dividing and subdividing until they become of very small size; whilst the chief veins tend towards the surface of the hemispheres, where they enter into great cavities or **sinuses**, by which the blood is carried off to the great veins of the neck. The special feature of the arrangements for the blood-supply of the brain is that only very small vessels ramify in the brain substance. The gray matter contains a much denser network of fine vessels than the white matter.

The average weight of the human brain is about 49 oz. for the male and 44 oz. for the female, the average male brain being thus about 5 oz. heavier than that of the female.

In both sexes the weight of the brain increases rapidly up to the seventh year, then more slowly to between sixteen and twenty, and again more slowly to between thirty-one and forty, at which time it reaches its greatest size and weight. As age advances it diminishes in weight at the rate of about 1 oz. for each period of ten years.

Other things being equal, the size and weight of the brain bear a general relation to the mental power of the individual. The brains of many eminent men have been found to be 8 to 14 oz. above the average weight, but these are notable exceptions. The brains of idiots are always small; indeed, any weight under 30 oz. seems to be invariably associated with idiocy. The human brain is absolutely heavier than that of any other animal except the whale and the elephant. The brain of a whale, 75 feet long, weighed upwards of 5 lbs., whilst that of an elephant is from 8 to 10 lbs. The average proportion of the weight of the brain to the total weight of the body is greater in man than in most other animals, being about 1 to 36·5; but in some small birds, the smaller monkeys, and in some other animals the weight of the brain to that of the body is even greater than what it is in man.

The Spinal Cord.

The spinal cord is in direct continuation with the brain by means of the medulla oblongata, and passes down the back, lodged in the canal formed by the rings of the vertebræ. It is from fifteen to eighteen inches long, and terminates at the level of the first lumbar vertebra, tapering off to a fine thread. It is about the thickness of the little finger, but is thicker in the region of the neck where the nerves for the upper limbs pass off, and also at the lower or lumbar end where the nerves for the lower limbs emerge. Like the brain it is closely invested by a very delicate membrane, the **pia mater**, by which blood-vessels are conveyed to the substance of the cord, having also an outer tough, fibrous coating—the **dura mater.** Between these two are the delicate serous layers of the **arachnoid** membrane inclosing a space between the dura and pia mater. This space contains a certain amount of fluid—the **cerebro-spinal fluid**, similar to the fluid in the ventricles of the brain. Finally, between the cord inclosed by its three membranes and the bony walls of the spinal canal there is a considerable amount of fatty tissue, acting as packing material, embedded in which are some large blood-vessels. Thus, the cord is supported in the canal by its membranes; and by means of them and of the fluid and packing of fatty tissue it is protected from shocks and jars. Nerves, the **spinal** nerves, pass out from the cord at regular intervals along each side. There are thirty-one of these on each side; and they receive sheaths from the delicate membranes of the cord but

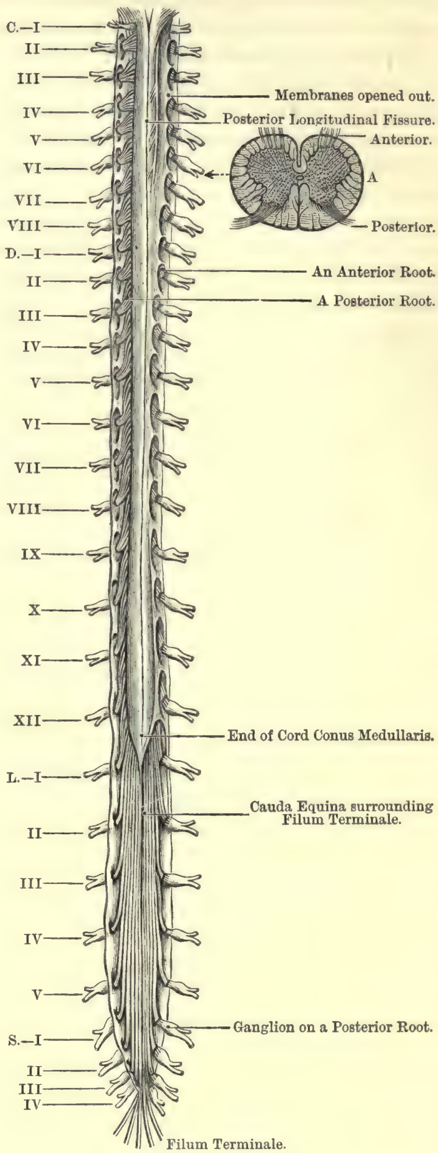


Fig. 84 *a*.—Representation of Human Spinal Cord—reduced.

C. I to VIII, Cervical spinal nerves. D. I to XII, Dorsal spinal nerves. L. I to V, Lumbar spinal nerves. S. I to IV, Sacral spinal nerves. A. In upper right-hand corner cross section of cord at level of 6th cervical nerve-roots.

pierce the dura mater. They issue from the bony canal by apertures, the intervertebral foramina, left at the sides between the opposing surfaces of the vertebræ, and, having escaped from the backbone, they pass backwards and forwards ramifying in the soft parts of the body. The first pair of nerves comes off between the skull and atlas, the next pair between atlas and axis, and so on down the canal. Thus eight pairs come off in the region of the neck—the **cervical** nerves, twelve pairs are **dorsal**, five are **lumbar**, and five **sacral**, while the last pair comes off behind the **coccyx**. The upper pairs come off at intervals and pass directly outwards through the openings in the canal for them. The lower pairs, however, to which belong the large nerves for the lower limbs, come off very near one another at the lower end of the cord and then pass down the canal in a bundle called **cauda equina**, from their resemblance to the tail of a horse, one pair passing outwards one after the other as they reach their respective openings. (Refer to Fig. 84*a*.)

In its structure the spinal cord resembles the brain, consisting of gray and white matter, but the arrangement is different. In the brain the white matter is within and the gray matter is spread on the surface of the convolutions. In the spinal cord the gray matter, which is characterized by large cells with many processes represented in Fig. 76 (*a* and *e*), is gathered *in the centre* into two half-moon-shaped masses, the backs of the masses being connected at the central part of the cord. The white matter, consisting mainly of fibres, is outside of and surrounds these gray crescents. In the centre of the cord, in the midst of the bridge of gray substance that unites the gray crescents, is a microscopically small canal, the **central canal** of the cord, which is continuous with the fourth ventricle of the medulla oblongata. The cord itself is almost divided into two lateral halves by a fissure or cleft which passes backwards from the middle line in front to within a short distance from the central canal. A division is also made behind between the right and left half of the cord by a partition of the pia mater that dips inwards from the middle line behind, also to a very short distance from the central canal. Thus there is formed a division, as it were, between the right and left side, each side having its own gray crescent, the horns of which point one forwards and the other backwards. The horn pointing forward is called the **anterior horn** or **cornu**, the other is the **posterior horn** or cornu. Now, from these horns there pass off strands of nervous substance which form the roots of the spinal nerves. Thus, from the anterior horn of one side there passes off a strand which issues from the cord towards the front, and is the anterior root of a spinal nerve, from the posterior horn of the same side a strand passes off behind to form the posterior root of a spinal nerve. These two strands, having issued from the cord, curve round, meet and join one another at the side, and by their union a spinal nerve of one side is formed, which then passes out of the canal by its intervertebral opening. Similarly from the other side a spinal nerve is formed by the union of an anterior and a posterior root. On the posterior root, before it joins the anterior, is a ganglion, *g* of Fig. 84 *b*.

Fig. 84 *b* represents the spinal cord **cut across**, as it would appear on looking down on the cut surface of the section. I. is the fissure in front, II. is the division between right and left behind, caused by the dipping in of the pia mater. The shaded portion in the centre represents the gray crescents with the connecting bridge, in the middle of which is the central canal *cc*; *ar* is the anterior root, *pr* the posterior root. The two roots unite to form the spinal nerve *sp*, and the nerve afterwards divides into two divisions, one going to the back of the body, and the other going to the front of the body.

The roots of the spinal nerves map off the white matter of the cord into columns. Between the anterior root of each side and the anterior fissure is the **anterior column**, AC, between the two roots at each side is the **lateral column**, LC, and between the posterior root and the posterior fissure is the **posterior column**, PC. In the white matter there are no groups of nerve-cells, but in the gray crescents are numerous groups of nerve-cells, NC, specially

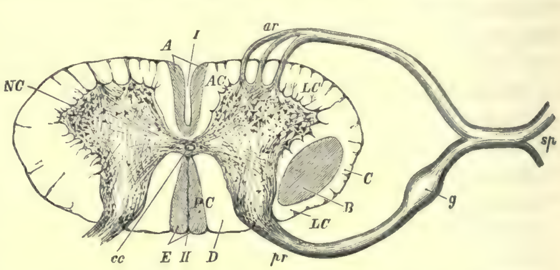


Fig. 84 *b*.—Cross Section of the Spinal Cord. Partly diagrammatic. Magnified. For references see text, and also p. 92*, where certain references not requiring notice here are explained.

in the anterior cornua. These are roughly indicated in the diagram.

The Functions of the Central Nervous System.

To disentangle the fully-developed human nervous system, or that of any of the higher animals, in order to determine the relations and duties of the various cells and fibres of which, as we have said, it is built up, would be an impossible task. The structure is so delicate, the weaving and interweaving of fibres are so complex, the orderly disorder of cells so great that the destruction of the tissue is the main result of any attempt to unravel it. Nevertheless various methods of inquiry and experiment yield a fairly consistent general view of the relations and functions of the different strands of fibres and groups of cells though, to render one's knowledge full and exact, innumerable details remain yet to be discovered.

The study of the development of the nervous system, from the lowest organism possessing any nerve structure at all up to man, and the gradual increase in its complexity from below upwards, attended, as such increase of complexity always is, by greater elaboration of function, throws much light upon the problem. The study of the development of the nervous system in one kind of animal has of recent years yielded much valuable information, since it is found that certain strands of fibres in the spinal cord reach their full development sooner than others. The examination of the spinal cord of an animal in a stage of its development will show certain fibres fully formed, others only in process of formation, and the course of the fully-formed fibres can therefore be traced through the cord and distinguished from those of the less fully-formed fibres. Further, the spinal cord can be removed from the body of a newly killed animal, can be hardened by various reagents so as to stand being cut into slices—sections, as they are called—of extreme tenuity, and stained by pigments of various hue. All the fibres are not alike when viewed under the microscope, but vary in size and in other respects, so that by cutting a continuous series of sections, staining them, and mounting them on glass slides in proper order, groups of fibres can be traced by their microscopic characters from one section to another onwards in the cord.

Experiment yields much information. Thus, if the destruction of a limited area of the cord is followed by loss of power in certain groups of muscles, the conclusion is obvious that the fibres in that part of the cord conduct impulses leading to the movement of these muscles; or if stimulation, say by an electric current, of a definite limited region on the surface of the brain in a living animal always leads to the action of the same muscle or group of muscles, the conclusion is obvious that that area of brain is related to the particular movement. This conclusion would be strongly confirmed if destruction of that particular area were always followed by the loss of that particular movement and by no other obvious effect.

Nature, unfortunately, "so careless of the single life", is prone to experiment by the agency of disease with far greater frequency and freedom than the experimental physiologist or pathologist, and the examination, after death, of the brain, cord, and nerves of a person who has died of some nervous disorder, and the relation of the alterations found in the diseased structure with the symptoms observed during life, have been prolific of information.

By collecting and comparing all the facts derived from these various methods of observation and inquiry, our present knowledge of the connections and functions of the nervous system has been built up.

What the nature of that knowledge is an attempt will be made to set forth briefly and with as little elaboration and detail as possible, anything beyond a very broad and general view being impossible in a treatise such as this.

The earliest indication of a nervous structure is found in that class of animals to which, among others, the polyps and medusæ belong (Cœlenterata). The hydroid polyp is tubular in shape, and consists of an outer and an inner layer of cells, between which is a middle layer of modified cells. If any part of the outside of the animal be touched it responds by moving. This response to an external stimulus is not in itself proof of the existence of a nervous structure, for apparently undifferentiated protoplasm will so respond. But microscopical investigation has shown that certain of the cells of the outer wall are peculiarly modified on their outer or exposed ends, and that from their inner deep ends processes run in to the middle layer. It is believed that these peculiar cells are fitted to receive an impression from contact with an external body, which impression they transmit by the deep processes to the middle layer, the result of which is contraction of the middle layer and the movement of the body.

Here, then, is the beginning of a nervous system, one cell placed on the surface so modified as to be fitted to receive and transmit an external impression to another cell, deeply placed, modified so as to contract on the receipt of the stimulus, a process of the surface-cell being the channel of communication.

In the medusæ the anatomical structure is more elaborate. Here there are special cells on the surface, fitted to receive external impressions, and cells placed deeply, modified into fibres, fitted to contract when stimulated, as in the polyp, but the connection between the two is less direct. Delicate filaments connect the outer cell with the deeper fibre. But in the course of the filaments is a mass of nucleated protoplasm, a nerve-cell. So that the external impression is made on a surface-cell, transmitted from it to a nerve-cell by a fine filament, and then by means of another filament the impulse is passed on to the muscle-fibre, resulting in a contraction. Here the nerve-cell is the intermediary between the outer perceiving-cell and the deep contracting fibre, and there can be no doubt that the intermediary nerve-cell plays a more important part than merely transmitting the impulse inwards. The filaments connecting the nerve-cell, on the one side with the surface, on the other side with the deep parts, we may now call nerve-filaments. Moreover, the nerve-filaments are so numerous as to form a marked ring of fibres running in the margin of the bell, and the cells lie among them, and there cannot be a doubt that the arrangement is not simply that of one cell on the surface being connected through the medium of nerve-filaments and cell with one muscular fibre deeply placed, but a more complex one by which intercommunicating nerve-filaments connect nerve-cells with one another. As a result of this intercommunication it is possible to have not only definite limited movements of simple muscle-fibres, but complex, co-ordinated movements, in which numerous fibres take their appropriate part. For, corresponding to the increased complexity of the anatomical structure, there is increased complexity of function, the medusa responding to an external stimulus, not merely by a single simple movement, but by complex movements, for example, of locomotion, or by discharge of stinging cells for defence, or by modification of the three, or by some movement indicating not merely the fact that a stimulus has been perceived, but even that the position of the stimulated part of the surface has been appreciated.

Now, when in the light of such facts an animal higher in the scale is examined, the character of the nervous system is more easily understood. The nerve-cells are found collected into more well-defined groups and the nerve-filaments into more well-defined strands. The groups of cells with the fibres connecting them together are called **ganglia**. The strands of nerve-fibres obviously connect the ganglia with well-defined areas of the body, certain nerve-fibres connecting the ganglion with the surface of the body and others with the deeper parts. The essence of the functions they perform is the same. Some stimulus, applied to the surface, will cause an impression to be conveyed to some cells of the ganglion, and then from these cells an impulse will pass by other fibres to deeper parts, leading to movement or some other action. Moreover, one ganglion is visibly connected with another, so that the impression received by the cells of one ganglion, which takes note of stimuli affecting one part of the body and regulates the actions of that part, may be communicated to the ganglion of another part of the body, leading to co-ordinated action of both parts.

In animals still higher in the scale of organization the increase in the development of parts and in the complexity of functions necessitates more numerous ganglia and more numerous fibres, connecting them with the region of the body over which each ganglion presides, and with one another. Thus in the ant (Fig. 80) there is a regular chain of ganglia and intercommunicating fibres.

Movement, in response to an external stimulus, has been taken as the illustration of nervous action, because it is the most obvious one. So increased variety of possible movements, the appearance of rhythmical movements, and the adjustment of limited movements for particular purposes, have been referred to as illustrations of increased complexity of function necessitating increased development of nerve-fibres and cells. But lest the exclusive use of this illustration should mislead the reader, it is necessary to say, what is of course obvious, that the gradual increase in the development of parts and complexity of functions, observed as one ascends in the scale of animal life, may be illustrated in a multitude of other ways, for instance, in the appearance and development of digestive organs, of a heart and blood-circulating apparatus, of secreting glands, of organs for the removal of waste substances from the body, such as lungs and kidneys. The functions which all these parts perform are maintained and regu-

lated by nervous action. Just as the action of a muscular fibre is performed in response to a stimulus from a nerve-cell, and just as that nerve-cell discharges its stimulus down a nerve to the muscle in response to some impression received from without, so all the organs referred to are caused to perform their functions by impressions from nerve-cells conveyed to them along nerve-fibres. So also the nerve-cells do not act automatically or spontaneously in controlling the action of the various organs, but are roused to action by impressions reaching them from without. The increase in nerve-ganglia, therefore, and in the nerve-fibres connecting them with different parts of the body and with one another, which is observed as one passes from lower to higher animals, is necessitated by development in a great variety of ways.

A phrase has been used suggesting that a ganglion presides over a part of the body, receiving impressions from it by one set of fibres and controlling the changes in it by impulses discharged along other fibres. It has also been mentioned that one ganglion is connected with others, so that the changes going on in one part may be related to those going on in another, that the harmonious working of all the parts may be maintained. This is specially well seen in certain animals, such as worms, where the body of the animal obviously consists of a series of segments, arranged longitudinally, each segment in its main features resembling the others. Each segment has its own ganglion or ganglia and related nerves. Still further, in animals of a certain degree of organization there is an obvious symmetry between one side of the body and the other, so that the body can be divided into two lateral halves markedly resembling one another; and this symmetry is reproduced in the nervous system. Instead of one ganglion presiding over one segment of the body with its related nerves, there is a pair of ganglia side by side, each with its related nerves, and each presiding over its lateral half of the segment, the two being closely connected by fibres passing between. Fig. 84*c* illustrates such paired ganglia, in which the two ganglia are close together, the fibres connecting them not being, therefore, obvious, but in other animals they are widely separated, and the **commissural fibres**, as the connecting strands are called, are quite distinct.

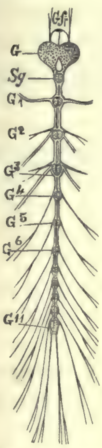
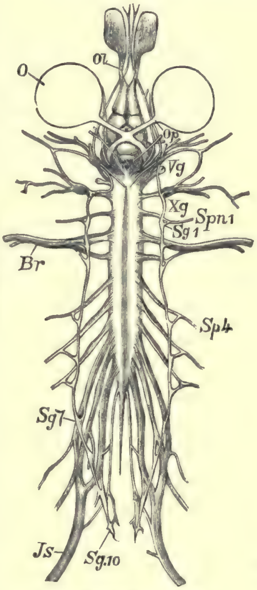


Fig. 84*c*.—Nervous System of the Larva of Coccinella.

G, Ganglion in front of gullet. *Gfr*, Frontal ganglion. *Sg*, Ganglion below gullet. *G*1 to *G*11, Ganglia of chest and abdomen.

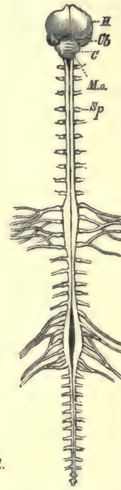
Here we must repeat that however ganglia are multiplied by the requirements of increasing complexity of structure, and however numerous and large become the nerve strands connecting them together, the type and essence of the whole structure is that already described. The



Nervous System of the Frog.

Ol, Olfactory nerves. *O*, Eye. *Op*, Optic nerve. *Vg*, Gasserian ganglion. *Xg*, Ganglion of vagus nerve. *Spn*1, First spinal nerve. *Br*, Nerve to anterior extremity. *Sg*1 to 10, Ten ganglia of sympathetic system. *Js*, Ischial nerve.

Fig. 84*d*.



Nervous System of the Pigeon.

H, Great brain. *Cb*, Optic lobes. *C*, Small brain. *M.o.*, Medulla. *Sp*, Spinal nerves.

type is a nerve-cell with a nerve-fibre carrying an impression inwards, which impression provokes some change in the cell, as a result of which an impulse is discharged outwards by another nerve-fibre resulting in some change in muscular fibre, or blood-vessel, or gland, or other structure. The fibre carrying the impression inwards is called an **afferent** or **sensory** fibre, and the fibre conveying the impression outwards, **efferent or motor** fibre, and the process is known as a **reflex action**. Refer to page 87, where this is more fully explained. We may now add that while an afferent fibre carries impulses only inwards to the cell, and the efferent only outwards to the muscle, vessel, gland, &c., the two fibres may, and indeed very commonly are, bound up in the same strand or nerve-trunk. The nerve-trunk in such a case

contains both motor and sensory fibres, conveys impulses, that is to say, both outwards and inwards. This is called a mixed nerve.

Now let us see what stage we have arrived at in our effort to understand the building up of a nervous system. The simplest conceivable nerve mechanism is a nerve-cell with an afferent and efferent fibre. Nerve-cells are grouped into ganglia, nerve-fibres into strands. As complexity of structure increases, ganglia, and the nerves connecting them and the various organs and parts of the body, multiply, but they are more or less symmetrically arranged, till a double chain of ganglia with connecting strands is reached. As complexity goes on increasing, the ganglia come to be more closely placed, till they and their connecting strands become fused, so that at last a continuous cord is developed, nerves radiating from it.

Fig. 84 *d* illustrates the nervous systems of a frog and a bird. Let the brain be neglected in each case. In the frog the bilateral arrangement is shown by the groove partially dividing the spinal cord into two lateral halves, while the segmented arrangement is just indicated by the regularity with which the nerves come off from each side. Here, that is to say, the chain of paired ganglia with their commissural fibres have become fused into a continuous cord, the construction of which it would be impossible to understand but for the previous study of more elementary forms.

The similarity between these and the spinal cord of man is too obvious to need comment (Fig. 84 *e*). The bilateral symmetry of the human body is quite apparent, and if the development of the human body be studied, its segmented arrangement becomes quite clear. Thus the study of comparative anatomy and of development would lead one to conclude that the spinal cord of man and the higher animals consists essentially of paired ganglia arranged longitudinally, the two ganglia of each pair being closely bound together and each pair closely bound with every other by commissural fibres, each pair presiding over and regulating the changes occurring in its own segment of the body (the process going on being of the nature of a reflex action), one ganglion of each pair looking after its own lateral half of the segment, the connection of the ganglion with its lateral half segment being effected by means of afferent and efferent fibres, the whole being fused and bound together into one apparently continuous structure. And this is the truth, though not the whole truth. The view just stated receives corroboration from the mere naked-eye inspection of the human spinal cord. It is not of uniform thickness throughout its length, but is markedly enlarged at the upper and lower ends. It is at the level of these enlargements that the nerves come off which supply the upper and lower limbs, and a microscopical examination of sections of the cord at these

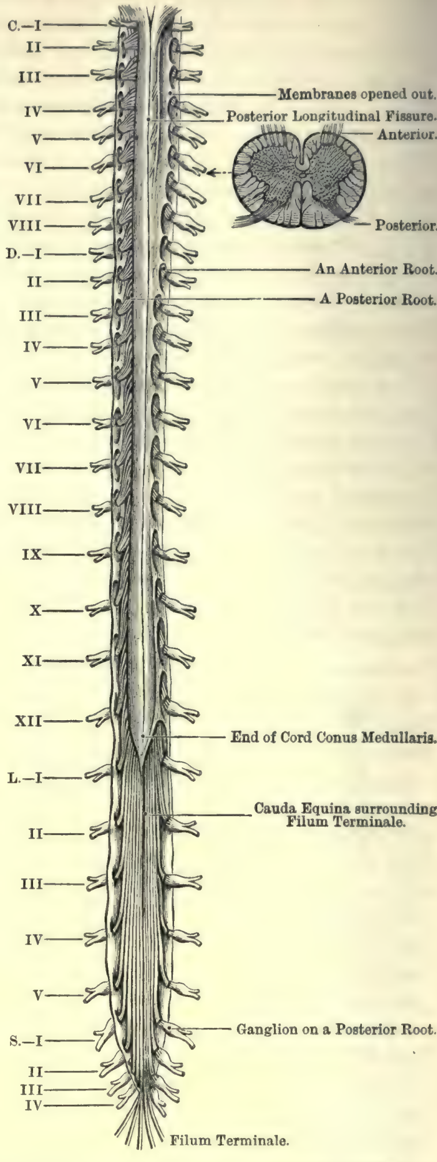


Fig. 84 *e*.—Representation of Human Spinal Cord—reduced.

C. I to VIII, Cervical spinal nerves. D. I to XII, Dorsal spinal nerves. L. I to V, Lumbar spinal nerves. S. I to IV, Sacral spinal nerves. In upper right-hand corner cross section of cord at level of 6th cervical nerve-roots.

levels show groups of nerve-cells particularly large and numerous. That is to say, to meet the requirements of the limbs there occurs a considerable multiplication of ganglia in the segments of the cord with which they are connected. Then a cross section of the cord appears to the naked eye to consist of two absolutely identical lateral halves, held together about the middle by a narrow connecting fibrous bridge.

Leaving, for the time, our consideration of the cord with this general understanding of the plan of its structure and of its functions, let us turn to the brain. Here again light is thrown on the subject by comparative anatomy and the anatomy of development. Even in some of the least-developed organisms there is a marked difference in size between the ganglion nearest the anterior extremity or head of the animal and the succeeding ganglia. Fig. 84 *c* (p. 95) shows this, where the first pair of ganglia (G) are very large, and are so connected with the succeeding pair (s*g*) as to form a ring. Through this ring the gullet of the animal passes. This special development in this region is due to the necessity of nervous arrangements for the regulation of the means of introducing food into the body and of special organs, organs of sight, of hearing, tactile organs, and so on, and in these animals this ganglion is comparable in many ways to the brain of man and the higher animals. The anatomical similarity between this ganglion in invertebrate animals and the brain of vertebrates is readily seen when one compares such specially developed ganglia of the highest invertebrates with the brain of the lowest vertebrates. Still more obvious becomes the similarity when one studies the development of the human nervous system. For in a very early stage of human development the nervous system consists of a straight tube of nervous matter running down the back portion of the body, that is, a spinal cord merely; and in the lowest vertebrate—the lancelet or amphioxus—there is no more than this, the anterior end of the cord being slightly swollen, representing the barest rudiment of a brain, being connected with a rudimentary eye and olfactory organ. As the development of the human embryo proceeds, the anterior end of the spinal tube enlarges into a bladder-like growth, which by constriction in two places becomes marked off into three, and these subsequently, by constriction of the first and third, into five little bladders or vesicles. These are the rudiments of what become subsequently developed into the fully formed brain by expansion of parts and by growth of new material and thickenings in their walls (Fig. 85). As growth goes on the tube is encroached upon until only a fine canal remains, still traceable in the fully formed brain. At first the nerve tube is quite straight, but as development goes on it becomes bent, and the parts of the brain become folded upon one another, certain parts undergoing such rapid development as to overlap and cover other parts, so that at last the exceedingly complicated brain is produced, the relations of the parts of which it would be impossible to determine unless one were acquainted with its mode of development (Fig. 85 *a*). The brain, that is to say, is really an outgrowth from the spinal cord, constructed, to begin with, on the same type, consisting of ganglia with connecting fibres and with their respective ingoing or afferent and outgoing or efferent nerve tracts. This extension of the spinal cord is made to meet, in the first place, the demand for largely augmented nerve arrangements to supervise the great elaboration of structure and function that takes place within the very limited area of

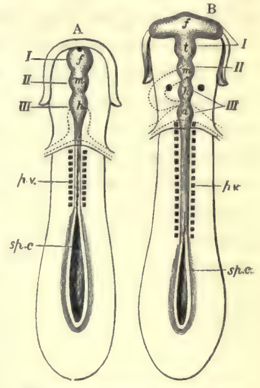


Fig. 85.—Development of Brain.

A, the stage of three primary vesicles. *f*, Fore-brain; *m*, mid-brain; *h*, hind-brain; *pv*, primitive vertebræ; *sp.c*, spinal canal not yet fully closed in; I, II, III, the primary vesicles.

B, the stage of five vesicles. *f*, Fore-brain, and *t*, twixt-brain, from the first vesicle; *m*, mid-brain, second vesicle; and *h*, hind-brain, and *a*, after-brain, from third. Other references as in A.

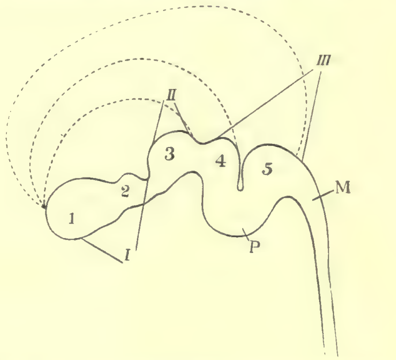


Fig. 85 *a*.—Stages in the Development of Cerebral Hemispheres from Fore-brain.

1, 2, 3, 4, 5 refer to the brain vesicles. I, II, III, are the parts forming the three primary vesicles. P, Pons Varolii. M, Medulla oblongata.

the head, that elaboration being connected with the varied and delicate movements of the face, of the jaws and tongue, and with the development, to a very high state of perfection, of special organs of sense connected with sight, hearing, smelling, taste. And indeed the cranial nerves, with the exception of the optic and olfactory nerves, are exactly comparable to the nerves coming from the spinal cord, the primitive type of which we have seen to be an afferent and efferent fibre connected with a nerve-cell in a ganglion. The ganglia of the cranial nerves, however, are not arranged in the brain in the same obvious orderly series as those of the spinal nerves, but become scattered and divided up by the great development of nerve structure that occurs in the brain.

To complete our physiological view of the building up of the brain certain other things must now be taken into account.

The process termed reflex action, which has been explained (p. 87), is sufficient to account for the various movements and changes which occur in the lowest organisms. Certain modified structures in or on the external wall of the animal are affected by changes in the medium in which the animal lives, and impressions are produced on them which, transmitted through the medium of nerve-cells, lead to movements of the animal. Similarly, changes, in one part of the body of the animal lead by reflex action to changes in another part, and the close connection of nerve-ganglia with one another by commissural fibres ensures the co-operative action of the body as a whole. This does not imply any conscious perception on the part of the animal, either of the stimulus applied to a part of the body or the change which it evokes. But in the higher animals this consciousness exists. Consciousness is undoubtedly a function of nerve structure, requiring a mechanism of nerve-cells, however impossible it is to understand how the activity of nerve-cells becomes transformed into a mode of consciousness, and it seems certain that some part of the brain is associated with consciousness. A blow on the head may deprive a man of consciousness for the time, or some disorder of the brain, but still the functions of animal life go on, and reflex actions occur, showing that, while the functions of some of the higher ganglia are in abeyance, the remainder are unaffected. One might say that the blow or brain disorder had temporarily reduced the man to the condition of some of the lower animals. Here then, in the higher animals and man, is a new function, provided for by a special development in the brain. Now notice carefully what this implies. If an impression be made on some part of the body of a conscious animal, that impression would affect an afferent nerve and would pass, in the first place, to its connected ganglion, let us say in the spinal cord. If no interference occurred, it would excite a change in the ganglion in the cord, as the result of which an impulse would be discharged from the ganglion down an efferent nerve, and some movement or other change would result. But the animal is conscious of the impression, and the nerve-centres for consciousness are situated in the brain. This implies that the impression, besides reaching its proper ganglion in the cord, and setting agoing there the changes referred to, must have travelled up the cord along afferent fibres and reached a higher centre —the centre for consciousness in the brain. In the spinal cord of the higher animals and man, then, besides groups of nerve-cells constituting ganglia, and their commissural fibres, with the afferent and efferent nerves of each ganglia, there must be afferent tracts passing upwards to other ganglia in the brain, and these must be related somehow to the afferent nerves passing to the cord and the ganglia of the cord to which they pass.

Let us go a step further. We have said that reflex action is sufficient to account for the movements made by, and changes occurring in, the bodies of lower organisms. If such organisms were subject to no external impulses whatever, it is safe to assume they would remain motionless. But in more highly-developed animals changes are initiated by the animal itself, apart from any external impression, as well as in consequence of such external impressions. The animal, that is to say, is endowed with volition, or will, in a more or less developed form. This new capacity also requires a nervous mechanism which is situated in the brain, and by destruction or removal of a certain portion of the brain, this capacity is lost, and the animal is reduced to the condition of a lower organism, requiring an external stimulus to set reflex action in operation and produce movement. For instance, if a frog be deprived of its cerebral hemispheres, "unless disturbed by any form of peripheral stimulus, it will sit for ever quiet in the same spot, and become converted into a mummy. All spontaneous action is annihilated. Its past experience has been blotted out, and it exhibits no fear in circumstances which otherwise would cause it to retire or flee from danger. . . . Surrounded

by plenty it will die of starvation; but, unlike Tantalus, it has no psychical suffering, no desire, and no will to supply its physical wants" (Ferrier). Now the meaning of this is, that in such more highly-organized animals, certain centres exist in the brain which have the power of initiating impulses leading to movement. This implies that from these centres there proceed efferent nerve-fibres which, passing through the brain, descend the spinal cord, and issue thence along efferent nerves to the muscles which are then excited to movement. It can be shown that these fibres descending from the brain are in some sort of communication with the ganglionic cells of the spinal cord, through which cells, indeed, the movements are effected. Thus the spinal cord consists of nerve ganglia united by commissural fibres. Each ganglion presides over a limited part of the body, receiving impressions from that part by afferent nerves, and exciting changes in that part by discharging impulses down efferent nerves, in response to the excitation brought by the afferent nerve. But in communication with the afferent nerve are other afferent fibres, which pass up the cord and carry the impression to centres in the brain, so that a consciousness of the impression arises. Also in communication with the ganglia are efferent fibres descending from centres in the brain, associated with volition. Thus, from the spinal cord ganglia, motor impulses may issue, either in consequence of an impression brought by an afferent nerve—that is reflexly—or in consequence of an impulse descending from the brain, as the result of an effort of will, initiated, that is to say, by the animal itself. Finally, to complete our general view, the higher animals are endowed with more or less intelligence, which in man reaches its highest development, including the faculty of memory, judgment, reason, imagination. These all require some nervous mechanism, and, humanly speaking, are inseparable from the activity of nervous structure, of nerve-cells. Only in a very rough way can the region of the brain, which is the seat of these operations, be indicated. Just as we have seen that in lower organisms the manifestation of higher functions is associated with increased complexity of structure, with increase in nerve-ganglia and their connected fibres, so are the beginnings of these higher mental operations associated with increased development of brain structure. The gradual evolution of these higher functions to more complete manifestation, as one passes from one animal to another higher in the scale, is accompanied by increase in brain structure and complexity. Upon the degree of development of the cerebral hemispheres depends the intellectual condition of the animal throughout the whole animal kingdom.

Let us now summarize the knowledge we have acquired of the functions of the central nervous system in man and the higher animals.

The spinal cord consists of a series of masses of ganglionic nerve-cells, disposed longitudinally and showing a bilateral arrangement. The masses are so close together as to be more or less fused, and are, besides, intimately connected with one another by communicating fibres. One or more ganglia presides over the functions of a part of its own lateral half of the body. With their own part the ganglia are connected, by afferent fibres carrying impulses to the ganglia from that part, and by means of efferent fibres impulses are discharged from the ganglia to that part which regulate the changes in muscle, vessels, glands, &c., in the part, the ganglia being by this means reflexly excited to action. By the commissural fibres impulses conveyed by afferent fibres to one ganglion may extend to other ganglia, and lead to changes affecting other and more distant parts. The spinal cord, further, contains fibres which carry afferent impulses upwards to the brain, and these are in some sort of communication with the afferent nerves of the ganglion, so that the afferent impulse, besides rousing a reflex action, may reach the brain and become a conscious perception, may give rise to some kind of sensation. The cord also contains fibres which descend from centres in the brain, conveying efferent impulses to the ganglia, which excite them, and thus changes are brought about initiated by cells in the brain, not involving a reflex act.

The brain is partly a development of the same system that exists in the cord, having ganglionic masses with related afferent and efferent nerves, specially connected with the head and face and organs of speech. In it are developed, besides, ganglia related to the special senses of vision, hearing, taste, and smell. There also are developed the nervous mechanisms associated with feeling, thinking, willing, &c., and certain portions of its structure are more or less directly connected, by strands of fibres, with the afferent and efferent parts of the cord. By means of these strands the brain becomes a controlling influence to the reflex centres in the cord, consciously perceiving an afferent impulse which otherwise would only unconsciously excite a reflex act, and consciously initiating

movements and other changes in the body, through the medium of the centres in the cord, which otherwise could only be called into action by a reflex stimulus.

Functions of the Spinal Cord and Spinal Nerves.

From what has been already said, we understand that the spinal cord consists of (1) a series of ganglionic masses of nerve-cells, each regulating by reflex action through their related afferent or sensory and efferent or motor nerve-fibres, the actions going on in a part of the body, and (2) of strands of nerve-fibres conveying sensory impulses up to the brain, and motor impulses down from the brain. A few more details of these functions will now be given. First as to the spinal nerves.

Functions of Spinal Nerves.—Each spinal nerve arises by two roots (see diagram, Fig. 85 *b*). If one anterior root of one side be cut, there is loss of the power of movement in the parts supplied by the nerve, and changes in the blood-vessels and glands of the part; that is to say, by the anterior root impulses issue from the cord regulating the contraction of muscles, and controlling the blood-vessels and glands. In other words the anterior root is motor. If a posterior root be divided there is loss of sensation in the part supplied by the nerve, and no disturbance of movement. Stimulation of the upper end of the divided anterior root produces no result, stimulation of the lower end causes muscular movements. Stimulation of the upper end of the divided posterior root elicits indications of pain, while stimulation of the lower end produces no obvious effect. The spinal nerve is, therefore, a mixed nerve, containing both afferent or sensory and efferent or motor fibres. Along the afferent fibres impulses pass to the cord, entering its posterior portion, so reaching the ganglion cells, which, thus excited, discharge impulses by the fibres of the anterior root, at the front of the cord, down the nerve to muscles, vessels, and glands. Any injury of the anterior root which separates it from the cord is followed by degeneration—wasting and decay—of the motor fibres of the mixed spinal nerve below the seat of injury. So the course of these fibres can be traced to their ultimate terminations and distinguished from the course of the sensory fibres of the mixed nerve, which remain unaffected. This is because the fibres have been separated from their nerve-cells in the cord, which, therefore, besides their other functions, preside over the nutrition of the nerve-fibres of the anterior root. These nerve-cells are those of the anterior horn of the same side. Disease destroying these cells is followed by degeneration of the fibres of the anterior root issuing from them, and paralysis of the muscles supplied by them. On the posterior root is a ganglion (*g*, Fig. 85 *b*); division of the root outside of the ganglion is followed by degeneration of the nerve-fibres beyond and throughout the whole course of the mixed spinal nerve, fibres of the mixed nerve derived from the anterior root remaining unaffected. Division of the posterior root between the ganglion and the cord is followed by degeneration of the part left connected with the cord, and the degeneration may in time be traced right up the whole length of the cord in its posterior portion, while the part of the root left connected with the ganglion, and all beyond the ganglion, remain unaffected. The nutrition of the fibres of the posterior root is, therefore, presided over by the cells of the ganglion of the posterior root.

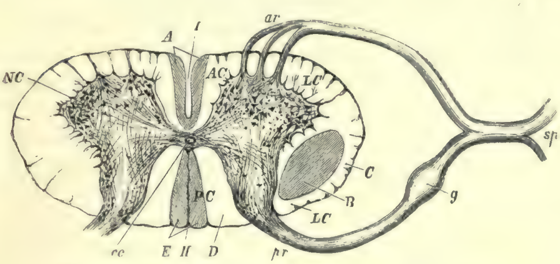


Fig. 85 *b*.—Cross Section of the Spinal Cord. Partly diagrammatic. Magnified.

I, Anterior median fissure. II, Posterior median fissure. *cc*, Central canal. AC, Anterior column (white matter). LC, Lateral column. PC, Posterior column, consisting of E, internal, and D, external position. NC, Nerve-cells of anterior cornu. A, Direct pyramidal tract. B, Crossed pyramidal tract. C, Direct cerebellar tract. *ar*, Anterior root of spinal nerve. *pr*, Posterior root. *g*, Ganglion on posterior root. *sp*, Mixed nerve formed by the two roots dividing into an anterior and posterior divisions to supply front and back of body.

Functions of the Spinal Cord.—Sensory or afferent impulses enter the cord by the posterior root. These impulses find their way to the cells of the anterior cornu of the same side, though no direct anatomical continuity has been traced between the fibres of the posterior root and the cells. The cells thus stimulated discharge impulses along the efferent fibres of the anterior root, which reaching muscles, &c. lead to movement. This is the reflex mechanism

of the cord. The cells of the anterior horn give off numerous processes which branch, and are lost in the fine meshwork of the cord, but there is always one process of the cell which issues from the horn, and becomes the central or axis cylinder of a nerve-fibre of the anterior root, so that a motor nerve-fibre which reaches a muscle, and conveys to it a stimulus leading to contraction, is a direct continuation of a process of a nerve-cell in the anterior horn of the same side of the spinal cord.

As to the portions of the cord in which impulses are conducted *downwards from* the brain, and *upwards to* the brain, to put it broadly, motor impulses descend from the brain in the anterior and lateral columns of white matter, the white matter consisting of nerve-fibres running longitudinally in the cord, while sensory impulses pass upwards in the posterior columns. In the figure the shaded parts (A) bounding the anterior median fissure and the shaded part (B) in the lateral column are the tracts down which motor impulses descend from the brain, while the shaded parts (E) bounding the posterior median fissure, and the unshaded portions (D) on both sides between the fissure and the posterior roots, are the tracts up which sensory impulses pass to the brain, leading to sensation. If the anterior portion of the cord be cut through **on one side**, the parts below the section **on the same side** are paralysed as regards motion, though sensation is not disturbed; while if the cut involved the whole anterior portion of the cord the body would be paralysed on both sides below the level of the section. To put it in another way, motor impulses from the brain to the one side of the body, with certain exceptions that need not be further noticed, pass down the antero-lateral columns of the cord on the side to which they are distributed. As to the tracts of sensory conduction the facts are not so clear. If a posterior root (that is a tract by which sensory impulses enter to pass up the cord) be divided inside the ganglion of the posterior root, the part of the root connected with the cord degenerates, and the degeneration can be traced in the posterior columns right up the cord to the medulla, where it ceases, and always on **the same side of the cord**, never crossing to the opposite side. This would lead to the opinion that sensory impressions coming from one side of the body passed up the posterior column of the same side of the cord. On the other hand, cases of disease involving the posterior portion of half of the cord have been numerous in which sensation was diminished on the opposite side of the body. Thus injury or disease limited to one half of the cord, but involving both anterior and posterior portions, produces loss of motion **on the same side** of the body, and loss or at least diminution of sensation **on the opposite side.** This fact suggests that sensory impulses, entering the cord from one side of the body, soon after entrance cross and ascend to the brain on the opposite side. It may be noted that there are different sensations coming from the skin, sensations of touch merely, or of pressure, or of heat and cold, or of pain, and that from muscles there is a sensation of resistance, which is called the muscle sense. Certain facts seem to indicate that these various sensations pass upwards in the cord to the brain along different nerve-fibres running in the posterior columns, so that disease affecting limited areas of the spinal cord may destroy the conducting paths for one sensation, leaving the other tracts intact. For example, limited disease might destroy the conducting paths for sensations of pain, leaving intact the tracts along which sensations of touch, pressure, temperature, and muscular resistance pass. In such a case a pin thrust deeply into the skin would not give rise to a sensation of pain, but merely to one of contact.

Connections Between the Brain and Spinal Cord.

It will be useful here to note how the brain and spinal cord are connected. In the general view of the functions of the nervous system as a whole, it has been explained that before one can become conscious of an impression reaching the spinal cord, it must pass up the cord to a centre for consciousness in the brain, and that the impulse to voluntary movements begins in centres in the brain, and travels downwards to lower centres in the cord, through which the movement is ultimately effected. What is known about the pathways of sensory impulses up the cord to the brain, and of motor impulses down the cord from the brain? The spinal portion of the pathway has been noted above, we must now note the brain portion, and first the pathway of motor impulses, for these have been most clearly determined. In 1870 two German physiologists, Fritsch and Hitzig, discovered that the stimulation, by a galvanic current, of certain areas on the surface of the cerebral hemispheres gave rise to certain definite muscular movements. Since then a great many

other observers, abroad and in this country, notably Dr. Ferrier of London, have repeated and extended these experiments. The results have been corroborated by the effects of disease, and a summary of the accepted facts will now be given.

Fig. 85*c* is a diagrammatic view of the left side of the brain of the monkey. A well-

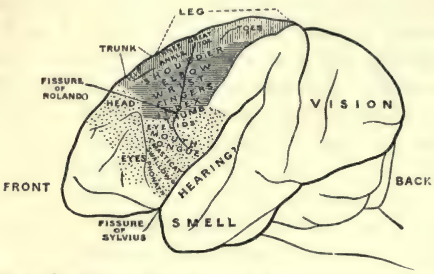


Fig. 85*c*.—Left side of Brain of monkey showing motor areas. See text.

marked fissure, the fissure of Rolando, dips deeply into the brain substance, running downwards from the middle line above. Stimulation of small areas in the convolution in front of this fissure, and in the one behind, produce certain definite movements, and the diagram itself indicates the parts that are moved. Destruction of these areas leads to loss of power of voluntary movement of the specified parts, and from the destroyed area degeneration can be traced downwards through the brain and into the cord. That is to say, it is in the cells of these areas that impulses arise, when the person wills to perform the particular movement, and the im-

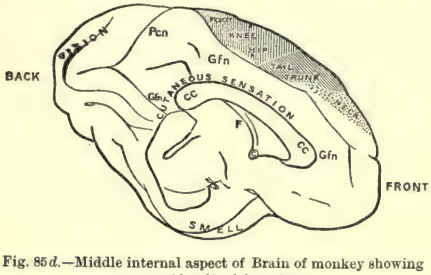


Fig. 85*d*.—Middle internal aspect of Brain of monkey showing areas of localized function.

pulse thus originated passes by efferent, *i.e.* motor fibres, through the brain and medulla oblongata to the spinal cord, down which it passes to reach the cells of the anterior cornu, from which efferent fibres proceed to the particular muscles to be moved. By means of the degeneration, which follows when any area has been destroyed, the pathway of the motor fibres proceeding from the area can be traced. Fig. 85*d* shows the median aspect of the left hemisphere when it has been separated from the right by a cut in the middle line from front to back, and it illustrates the fact that the **motor areas**, as they are called, are not limited to the outer side of the hemisphere, but are found also in the middle surface, the part next to the great longitudinal fissure (see p. 89). Now when the experiments are conducted on the *left* side of the brain, the movements occur on the *right* side of the body; when the *right* side of the brain is stimulated the movements occur on the *left* side of the body. When the explanation of this is sought, it is found that the motor fibres from the left side of the cerebral surface, after passing through the brain, reach the upper part of the spinal cord—the medulla oblongata—and there cross to the opposite side of the cord. The left side of the brain thus sends motor impulses to the right side of the body, and the right side of the brain to the left side of the body. Destruction of these areas, as has already been stated, causes loss of power of voluntary movement in the particular parts of the body they control, but, because of this crossing of fibres, destruction of the surface of the left side of the brain will cause paralysis on the right side of the body. These discoveries have been of infinite value in the treatment of disease. For, owing to them, it is now frequently possible to determine, in certain cases of paralysis of particular parts of the body or of convulsive movements of particular muscles, the exact site in the brain of the disturbing cause, and surgeons have thus been enabled to open into the part of the brain indicated and successfully remove the growth, splinter of bone, or collection of matter causing the disturbance.

From these motor areas the efferent fibres pass towards the base of the brain through the corpus striatum, thence through the crura cerebri and pons Varolii to the medulla oblongata. (These parts are described on p. 89.) When these fibres reach the medulla they form a well-marked strand, called the **pyramidal tract**. From each side of the brain there is a pyramidal tract. In the lower part of the medulla the tracts from each side cross one another, interlacing as they do so, so that the pyramidal tract from the right side of the brain crosses to the left side of the cord, and *vice versa*. This crossing is called the **decussation of the pyramids**. After crossing, the fibres pass down in the lateral column of the cord, forming the column of the crossed pyramidal tract (B of Fig. 85 *b*). Subsequently these fibres become connected with the cells of the anterior horn of the

gray matter of the cord, and then from these cells other fibres pass off to the muscles. Thus when one wills to move the *right* leg, an impulse starts in an area on the surface of the *left* side of the brain, passes through the brain to the base, reaches the medulla, crosses there to the right side of the cord, down which it passes along fibres of the lateral column, till it reaches the lumbar enlargement of the cord. There it enters nerve-cells of the right anterior cornu of the gray matter, which it excites. In consequence, the cells discharge energy along fibres of the anterior root, down the nerves passing to the muscles of the right leg, which thereupon contract, and the leg is moved. All the fibres of the pyramidal tract do not pass from one side to the other in the medulla; a few fibres pass down the cord on the same side, but ultimately cross in the cord. These fibres form a strand in the cord called the uncrossed or direct pyramidal tract, A in Fig. 85 *b*. It is not so easy to trace the course of sensory impulses up the cord to the brain. But it is known that such impulses pass up to the medulla, where they may reach nerve-cells, from which by other afferent fibres they may pass to the cerebellum or through the pons and crura to the cerebral hemispheres. In some part of their course sensory impressions cross like motor impulses from one side to another. Experiments have been directed to discover where the centres for the perception of sensations are situated in the brain, and the results are indicated in the diagrams (Figs. 85 *c*, 85 *d*). It is sufficient to say that though the areas in the brain for the conscious perception of sensory impulses have not been so accurately defined as the motor areas, the evidence is conclusive that definite groups of nerve-cells in the cerebrum are set apart for receiving all the varieties of sensations, and that if any of these areas be destroyed the power of perceiving the particular sensation is lost.

From the facts which have been explained it will be understood what is meant by the phrase **localization of function** in brain and spinal cord. The brain and spinal cord do not act as a whole in the multitudinous variety of nerve operations. One part of the brain or spinal cord—one group of nerve-cells—is set apart for one duty, another group for another duty, so that a particular function is limited to a particular group or groups of nerve-cells—the function is localized.

It now only remains to note briefly the functions of the various parts of the brain.

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Functions of the Various Parts of the Brain.

The Functions of the cerebral hemispheres have been already indicated. They are associated with mental phenomena—feeling, thinking, and willing, and with all conscious states. They are the seat of intelligence. An animal deprived of the cerebral hemispheres is only a very complicated mechanism, but a mechanism incapable of starting itself, though, when stimulated by some impulse from without, capable of as great a variety of complex and co-ordinated movements as an animal endowed with intelligence. But it is nevertheless only an elaborate mechanism, without consciousness, and incapable of spontaneous action. From the cerebral hemispheres originate all voluntary movements, through the cells of the motor areas, and only when sensory impulses reach them do these impulses rise into consciousness.

The **corpora striata** are concerned in the transmission downwards of motor influences, that is, nervous impulses which excite muscular contraction. Injury or disease causes paralysis of motion on the opposite side of the body, the motor fibres crossing in the medulla. Motor impulses do not originate in the corpora striata, but these organs receive the impulse from the higher centres in the cerebrum and transmit it downwards. Again, they may be concerned in reflex movements without consciousness. Thus a nervous impression, starting from the eyes, reaching the corpora quadrigemina is probably transmitted forwards to the corpora striata, and thence passes downwards to excite muscular contractions.

The **optic thalami** are sensory centres receiving impressions, probably those of touch, and transmitting them upwards to the cerebral hemispheres, where they may arouse consciousness. Injury or disease of these organs on one side causes loss of sensibility, or disordered sensibility, on the *opposite* side of the body, as the majority of sensory fibres cross from one side to the other in some part of their course. Just as the corpora quadrigemina are the recipients of *visual* impressions which may result in such complex muscular movements, as those of walking without consciousness, so the optic thalami perform the same functions in relation to impressions of touch.

The **corpora quadrigemina** are connected with the sense of vision and with the movements of the pupil. Disease or injury causes

dilatation of the pupil and blindness. The corpora also receive visual impressions which may be transmitted upwards to the cerebral hemispheres, resulting in a sensation of light; or they may cause co-ordinated or regulated movements without sensation. Thus visual impressions may cause well-regulated movements without the person being actually conscious of what he sees, as happens in somnambulism.

The **pons Varolii** contains motor and sensory fibres passing downwards and upwards, and, in addition, it contains centres of gray matter which are connected with the roots of some of the cranial nerves (Fig. 83, p. 89). Irritation of the pons causes very severe convulsive spasms. The pons also contains, as already stated, transverse fibres connecting one half of the cerebellum with the other half, thus securing co-operation between the two portions, but the exact way in which this is done is unknown.

The **cerebral peduncles** or **crura**, seen immediately in front of the pons in Fig. 83, contain both sensory and motor fibres. The sensory are in the back part of the peduncles, and pass upwards to the corpora quadrigemina, optic thalami, and posterior lobes of the cerebrum, whilst the motor fibres pass downwards from the corpora striata in the fore part of the peduncles. Injury to one peduncle sometimes causes an animal to move to the side opposite the injury, so as to describe a circle, somewhat in the manner of a horse in a circus.

The **cerebellum** is the regulator or co-ordinator of muscular movements. The mechanism by which it does so has not yet been satisfactorily explained. It receives nervous impressions connected with sight from the corpora quadrigemina, connected with touch by nerve-fibres coming from the skin and passing up the back part of the spinal cord, and also impressions associated with the sense of equilibrium by the nerve of hearing from the semicircular canals in the ear. (See EAR.) Disease of the cerebellum in the human being is rare, but when it does exist there is usually blindness, a dilated pupil, giddiness, a tendency to move backwards, and a staggering irregular gait. There is no loss of consciousness or other disturbance of the mental functions.

The **medulla oblongata**, connecting the spinal cord with the brain, may be regarded as a great nervous tract for transmitting sensory and motor impressions, and also as the seat of a number of centres for reflex actions of the highest importance to life. Motor transmission, that is, the transmission of nervous influences from above that result in contractions of muscles in some part of the body, occurs chiefly at the fore part of the medulla. Here also many of the motor fibres *cross from one side to the other*, as already explained (p. 94*). Through the medulla sensory impressions also pass, that is, impressions from below upwards, from the surface of the body to the brain, resulting in sensation or feeling; but their route is not accurately known.

The medulla is remarkable for being the seat of a number of reflex centres connected with the movements of the heart, the movements of respiration, the influence of the nervous system on the blood-vessels, the movements of swallowing, and the secretion of saliva. In addition, it is at least partly the origin of many of the important cranial nerves (p. 89). Consequently, injury to this part of the nervous system is quickly fatal, and in nervous diseases, or towards the close of life, when the power of swallowing is lost, we may infer that the medulla has become affected.

Localization of Function. These modern views of the localization of function in small areas of nervous substance are fitted to rouse grave reflections. We know that it is true of a muscle, that moderate and regular exercise of it conduces to its increased development and power. It is by constant exercise that the arms of those accustomed to manual labour are so strong and well formed. Further, we know that want of use causes a muscle to waste. An arm put up in splints for six weeks for fracture is much thinner than its neighbour at the end of that time, just because of its enforced idleness. *Proper use increases strength, want of use weakens.* There is no manner of doubt that these rules apply to the nervous system. Everybody knows that a man who regularly studies music, becomes by and by more or less of an adept at his art; everybody knows that the man who fitfully studies anything shows evident signs of his neglect. Now the application of these rules to what has been said about special centres in the brain, means that the systematic use of any faculty of the mind develops and strengthens the nerve-centre that presides over that faculty, and that disuse means waste of the nerve-centres. Thus, to put it broadly, a man may be supposed to be born with a brain, that may be thought of as a series of nerve-centres; these various centres have the *capacity* of being trained to discharge certain duties;

if the training be given, the centres will be developed, and the man will be able to perform the duty; if the centres be not trained they will degenerate and decay, and the man will be unable to perform the duty. People excuse themselves for defects of education, or other defects, by saying, "I have no head for this", "I have no faculty for that". This translated into stricter language would be, "I neglected to develop the capacity I once possessed, and it, consequently, has gone to waste".

The time for developing nerve-centres, for training or educating them, is naturally during the period when growth is possible, that is, in youth.

For if the nerve-centres are not exercised during the growing period, their development will not take place; and when the growing period is passed the risk of development being impossible is great.

A word of caution is necessary. While what has been said is an argument for an all-round training, a training of eye and ear, tongue and hand—training of every muscle of the body as well as of every faculty of the mind, it must not be taken to sanction overburdening and overstraining of nerve-centres. The runner training for a race does not begin at once to go at full speed for his full distance. He takes short distances at first and leisurely to accustom his muscles to their work, and he gradually goes further and faster, always avoiding exhaustion. So the training from the youth up should be prudent and regulated with a watchful care against over-work. For over-exertion and over-stimulation are as ruinous as neglect.

Phrenology. The view that certain little areas of brain substance are connected with certain functions is not to be confounded with phrenology, which maps out on the outside of the skull certain regions said to be devoted to certain emotions, &c., the prominence of the regions indicating the amount of development of the faculty, emotion, &c. The brain exhibits no such divisions as phrenology creates, still less can any prominence or depression on the outside of the head indicate, through scalp and bones, the shape of that part of the brain within. The phrenological theory was first propounded by Gall and Spurzheim in the beginning of the present century.

The Cranial or Cerebral Nerves.

There is a set of nerves, called the cranial or cerebral nerves, which pass from the brain through different openings in the skull, and are distributed over the head and face as well as to some parts of the trunk and certain of the internal organs. The nerves come off in pairs, one from corresponding parts of each side of the brain. Fig. 83, which represents the base of the brain, shows the places where these nerves issue from the brain substance. Reference should be made to that figure and to the description which accompanies it.

1. The first pair is the **olfactory**. They are bundles of very delicate nerve-filaments which come off from the olfactory bulbs which lie under the front lobe of the cerebrum. They pass down into the nasal cavity through the ethmoid bone. They are nerves of the special sense of **smell**. (See Sect. XII., SMELL.)

2. The second pair of nerves is devoted to the sense of **sight**. They are the **optic** nerves, and pass forward into the cavity of the orbits to reach the eyeballs. (See Sect. XII., SIGHT.)

3. The third pair is motor nerves, also passing into the orbits to supply the muscles of the eyeball. They are the nerves of motion for the muscles that turn the eye upwards, downwards, and inwards, and for the muscle that lifts the upper eyelid. They also supply the iris, that is, the circular curtain of the eye, by whose contractions the pupil of the eye is made larger or smaller. They leave unsupplied the muscle that turns the eye outwards, and another that turns it upwards and inwards. Thus, suppose this third nerve to be paralysed, the eye could not be turned upwards, or downwards, or inwards, but would be wholly under the influence of the two muscles already mentioned as independent of the third nerve. The eye would thus, by these two muscles, be kept drawn downwards and outwards. The upper eyelid would also be paralysed, and would droop over the eyeball and could not be lifted, while the pupil would be very large and immovable. It is obvious, therefore, that one eye would squint very much, and there would be double vision, two objects would be seen for one, owing to the want of united action between the two eyes.

4. The fourth pair of nerves is called the **pathetic** pair, because the nerves supply that one of the muscles, omitted by the third pair, whose contraction gives the upward turn to the eyes which we call call pathetic.

5. Each one of this pair of nerves is in three divisions, and proceeds mainly to the face. It is therefore called **trifacial**. They are mixed nerves, partly sensory and partly motor. The first division, however, is purely sensory, and

passes into the eyeball, on which it confers sensibility. The second division is also purely sensory, and gives sensation to the nose, and gums, and cheeks. The third division is partly sensory and partly motor. Its sensory branches confer sensibility for taste on the front two-thirds of the tongue, and ordinary sensation on the inner side of the cheeks and on the teeth, and also the scalp in front of the ear. Its motor branches supply the muscles of mastication (p. 70). Thus, paralysis of the fifth pair of nerves would destroy the sensibility of the eyeball, and would, moreover, cause ulceration and inflammation to appear in it, would destroy to some extent the sense of smell and the sense of taste, would abolish sensation from the skin of the face, and would cause paralysis of the muscles of mastication, so that the movements of chewing would not be performed. If paralysis occurred to the nerve of one side only, that side of the face and tongue would be deprived of feeling, and the muscles of that side of the jaw being palsied the jaw would be wholly under the control of the opposite side, and would be pulled to the other side, so that the upper and lower teeth would not correspond.

6. The sixth pair is called the **abducent** or abducting pair of nerves, because they are motor nerves and supply the muscle that abducts or turns the eye outwards. This muscle was omitted by the third pair. Paralysis of the nerve leaves the eyeball under the influence of the opposite muscle, namely, that which turns it inward, so that the eye has an inward squint.

7. In each of the seventh pair of nerves there are two portions: the one called **portio mollis** (soft portion) is sensory, and is the **auditory** nerve—the nerve of **hearing** (see Sect. XII., HEARING); the other, called **portio dura** (hard portion) or **facial** nerve, is motor, and supplies the muscles of expression. Thus paralysis of the auditory portion would produce deafness; paralysis of the facial would produce palsy of the muscles of the face. The result of facial palsy is that the affected side is smooth, unwrinkled, and motionless; the eyelids, being also palsied, are wide open and cannot be closed; and the face is wholly under the control of the muscles of the opposite side, which, having it all their own way, drag towards that side, so that the mouth is pulled away round. Refer to FACIAL PALSY, p. 120.

8. The eighth pair is very complex. The eighth nerve of each side consists of three trunks which arise from the medulla oblongata, and leave the brain by one opening.

The first trunk is called **glossopharyngeal** (*glossa*, the tongue, and *pharynx*, the throat) because it supplies the throat and back part of the tongue. It is partly sensory, conferring taste on the back part of the tongue, and partly motor.

The second trunk is the **pneumogastric** (Greek *pneumōn*, the lung, and *gastēr*, the belly) or **vagus** nerve. It is both sensory and motor. Passing from the medulla it descends on the gullet to the stomach, sending off, on its way, branches to the throat, the box of the windpipe, lungs, and heart. Paralysis of one of its branches causes loss of voice; some of its branches exercise a restraining influence on the movements of the heart, others convey messages to the brain, which result in quickening or slowing movements of breathing; while by means of the branches passing to the stomach impressions are conveyed upwards to the brain which inform us of the condition of the stomach, and are the means by which we experience feelings of hunger, nausea, pain in the stomach, and many other indefinite sensations which we associate with that organ.

The third trunk of the eighth pair is the **spinal accessory.** It is a motor nerve; part of it, the accessory part, joining the pneumogastric, and part proceeding to two muscles, one of the neck, the sterno-mastoid, and the other of the back, the trapezius.

9. The ninth pair of nerves is the **hypoglossal** (*hupo*, under, and *glossa*, the tongue). It is a motor nerve, and passes along the under surface of the tongue to its tip. Paralysis of the nerve of one side renders that side of the tongue flaccid, and on putting the tongue out of the mouth it will be pushed out with its tip towards the affected side. Paralysis would also cause difficulty of speech, and difficulty of swallowing owing to the tongue not being able to perform the first act of swallowing, namely, push the food to the back part of the mouth.

The Sympathetic System of Nerves.

At each side of the backbone, from the base of the skull to the coccyx, there is a chain of swellings. These are the ganglia of the sympathetic system, and there are twenty-four or twenty-five of them on each side. The ganglia of one side are connected together by fibres running between them, while fibres also pass from the trunk of the nerve to the spinal nerves in the neighbourhood. At the coccyx the two chains unite in a single ganglion. At

the upper end the trunk of each side passes up into the skull and becomes intimately connected with the cranial nerves. In the neck branches pass from the chains of ganglia to the lungs and heart. From the ganglia in the chest three nerves pass off, called the **splanchnic** nerves, which together form a complicated network or plexus of nerve-fibres in the upper part of the belly. From this sympathetic plexus branches pass along blood-vessels to the stomach, liver, intestines, kidney, and other abdominal organs. A similar network of sympathetic fibres is situated lower down in the pelvis, from which branches pass to the pelvic organs. Thus in general the sympathetic system of nerves, while found intimately connected with the cerebro-spinal system, is found specially accompanying blood-vessels and supplying the glands and viscera, that is, the hollow organs of the body.

The **Functions** of the **Sympathetic** nerves are specially connected with the processes of organic life, the movements of the heart and of respiration, the work of the stomach and bowels in digestion, the process of secretion in glands, and so on. The impulses that proceed along the sympathetic nerves are not subject to voluntary control, and thus all those actions that have been mentioned that are necessary to the life of the body and the harmony that evidently subsists between the internal organs, which unites their action to one end—the maintenance of the animal life, are affected by the sympathetic system. One special function of this system is the control of the blood-vessels. By means of nerves distributed to the muscular coats of the arteries the width of these vessels can be varied, so that at one moment they will permit a large quantity of blood to pass to a part, and at another moment will contract so as to diminish the supply. This also is beyond the control of the will, and is effected by the sympathetic through a reflex arrangement, the centre for which is in the medulla oblongata. This will be explained in more detail in the section on the circulation of the blood.

The Distribution of Nerves.

The distribution of the cranial nerves has been already indicated. Each spinal nerve, after it has issued from its opening in the backbone, splits into two divisions, one of which proceeds to supply parts behind the spine, while the other passes forward towards the front. The first eight spinal nerves on each side are called *cervical*, the next twelve are *dorsal*, the next five *lumbar*, then five *sacral*, and one *coccygeal*. The front divisions of the first four cervical unite to form what is called the **cervical plexus**, from which branches are supplied to the muscles of the neck. One very important nerve springing from the group is called the **phrenic**, which passes down the front of the chest to supply the diaphragm or midriff, upon the movements of which breathing so much depends. The other four of the cervical nerves and one of the dorsal unite to form the **brachial plexus**, from which nerves proceed to the upper limb. They enter the arm from the arm-pit, which they cross in company with the large blood-vessels for the limb. One of them winds round a groove in the upper arm-bone and passes to the muscles of the back of the arm. It is called the **musculo-spiral** nerve. A second, the **ulnar** nerve, descends on the inner side of the arm. At the elbow it rests in an interval between the inner projecting process of the arm-bone and the point of the elbow. When the elbow is knocked at this place the shock given to the nerve produces the sensation ascribed to "knocking the funny bone". The nerve passes to supply the little finger and the neighbouring side of the ring-finger. If these two fingers become numb, therefore, it is due to paralysis of this nerve. The remaining fingers and the thumb side of the ring-finger are supplied by the **median** nerve, which passes down the middle of the arm. All these nerves are *mixed*, that is, they confer power of motion and sensation.

Of the twelve **dorsal** nerves the posterior divisions supply the muscles and skin of the back, the anterior divisions supply branches, called **intercostal nerves**, to the spaces between the ribs.

The five **lumbar** nerves also send their posterior branches to the back; while the anterior divisions of the first four unite to form a group called the **lumbar** plexus. From it branches pass to the belly and genitals, and large branches to the muscles of the front of the thigh, and to the skin of the front and inner side of the thigh, and to the skin of the inner side of the leg and foot.

There is also a **sacral** plexus, formed by the anterior divisions of the sacral nerves, reinforced by the last lumbar.

From this group proceeds the largest nerve in the body, the **sciatic** nerve—a neuralgic affection of which is called sciatica. It gives branches to the muscles at the back of the thigh, and branches also to muscles below the knee,

and to the skin of the leg and foot. The nerve escapes from the pelvis just outside of the seat bone, and passes right down the middle of the back of the thigh till the back of the knee-joint is reached, where it divides into two branches, called **internal** and **external popliteal**. The first of these branches continues the main course down the back of the leg, where it is called **posterior tibial**. It divides on the inner side of the heel into two branches, which between them supply the sole of the foot and the sides of the toes. The external branch turns round below the knee to the front of the outer side of the leg, down which it passes as the **anterior tibial**, supplying muscles on the way, and ends in branches to the skin of the back of the foot.

Section V.—THE NERVOUS SYSTEM.

B.—ITS DISEASES AND INJURIES.

Diseases and Injuries of the Brain:—

Inflammation (1) of membranes (*meningitis*), simple and tubercular, (2) of the brain itself (*cerebritis*);
Softening; Dropsy (*hydrocephalus, water in the head*);
Congestion; Apoplexy; Anæmia;
Coma, Compression and *Concussion* (shock);
Sunstroke and *Delirium Tremens*—dipsomania;
Insanity—Its Causes, Symptoms, Kinds (*Melancholia, Hypochondriasis, Mania, Monomania, Dementia, Idiocy, General Paralysis of the Insane*) Treatment—
Its prevention;
Headache and *Giddiness* (*vertigo*).
Somnambulism, Sleeplessness and *Nightmare.*

Diseases and Injuries of the Spinal Cord:—

Inflammation, Degeneration, Congestion, Spinal Irritation, Concussion, Spina Bifida.

General Nervous Diseases:—

Paralysis—Hemiplegia, Cross Paralysis, Paraplegia, Aphasia,
Local Paralysis—facial palsy,
Locomotor Ataxia, Shaking Palsy, Wasting Palsy, Pseudo-hypertrophic Paralysis, Infantile Paralysis, Lead Palsy;
Convulsive Diseases—Convulsions, Epilepsy, St. Vitus' Dance, Tetanus;
Hysteria;
Neuralgia.

Injuries of Nerves.

I. Diseases and Injuries of the Brain.

Disease of the brain may attack the brain substance itself, or it may affect the membranes, pia mater, arachnoid, and dura mater, which envelop it, or it may be situated chiefly in the cavities—ventricles—of the brain and their neighbourhood.

Inflammation, Softening, and Dropsy of the Brain.

Inflammation of the Membranes of the brain is called *Meningitis*, and may be of two kinds, **simple** and what is called **tubercular.** The latter is associated with a scrofulous taint.

The **simple** form is one of the most dangerous results of injuries of the head; but it may also be caused by violent mental emotions, exposure to cold or to the heat of the sun, and by excess in spirituous liquors. *One of the most frequent causes met with in practice is old standing disease of the ear.* The patient may have suffered for years from a "running at the ear." All the time the disease is slowly finding its way to the brain, and not infrequently the sudden stoppage of the discharge is the first occurrence in the attack.

Symptoms. Severe and constant pain in the head, now and again becoming unbearable, is very common. Sudden giddiness and vomiting may occur. Light painfully affects the eyes. There is fever, rapid wiry pulse, and often delirium, which sets in early, and may be violent or muttering. If the inflammation be due to ear disease, pressing with the finger on the bone immediately behind the ear is very painful, and may bring on the faintness and vomiting. These are in general the kind of symptoms, though they vary considerably. The disease is very serious, and may go on to intense prostration, when the excitement ceases and unconsciousness comes on. It may end in death within two or three days, or not till two or three weeks.

The **treatment** must be very vigorous. Strong purgative medicines must be given to get free action of the bowels as speedily as possible. Calomel and jalap, followed by salts, are best. (See PRESCRIPTIONS.) Iced cloths applied to the head are soothing. Then the head should be examined for injuries, as, if injury to the scalp be the cause, it is sometimes necessary to have a surgical operation performed. Should the bone behind the ear be tender, a blister or leeches should be applied there at once, though bleeding by a cut down to the bone at that place is best if a surgeon be at hand to perform it. If a discharge from the ear has existed it may be well to apply large hot poultices over the ear, besides using the blister. Milk diet only should be given, unless the disease is running a long course, and the patient is becoming exhausted, when beef-tea and stimulants may be necessary.

The **tubercular** form is so called because in it little nodules or tubercles are found after death in the membranes at the base of the brain. It has also been called **acute hydrocephalus, that is, acute water in the head,** because much fluid is found in the cavities of the brain, and softening of the surrounding brain substance. It is, as already remarked, frequently due to a scrofulous taint, and is not seldom found "running in families." It is not uncommon in children under five years of age.

Symptoms. The child attacked often shows signs of general ill-health for weeks before the disease is fully developed. The principal of these early signs are peevishness and restlessness, weakness, and falling off in health. *A very suspicious early sign is sudden vomiting without sickness and without any apparent cause.* The child may be wakeful at night, grinding its teeth and starting up in bed screaming. There may be also feverish turns. When at length the disease is fully developed it unfolds itself in three stages. *In the first stage* the child is highly fevered, with rapid pulse. It suffers from headache, which makes it scream out at intervals, and it is distressed by slight noises and by light. The bowels are usually confined. There is sometimes delirium. *In the second stage* the excitement ceases, and the child lies quietly, is with difficulty roused to say anything or to take food. He is indifferent to everything, and perhaps passes water and motions without knowledge. At intervals he utters a very peculiar, distressful, shrill, plaintive cry, which is characteristic of this disease, and convulsions may occur. His hands wander aimlessly about, picking the bed-clothes, or his nose and lips. *In the third stage* he becomes quite unconscious. *The pupils of the eyes are very wide, and do not contract when a light is brought near.* This stage may come on slowly or suddenly after a fit of convulsions. The pulse gets feeble and the skin cold and clammy. The child may die in a convulsion, or simply slip away. Death may occur within a few days, but frequently not for two or three weeks.

Treatment seems of little value in this disease, yet rare recoveries have taken place in cases presenting all its symptoms.

1. Place the patient in a quiet, darkened room, well ventilated and kept at a moderate warmth, and let the person be kept warm by flannel clothing if necessary.

2. Relieve the constipation of bowels by calomel and jalap (PRESCRIPTIONS), or castor-oil. If these fail, injections of castor-oil and hot water, or hot water and salt (see ENEMA), may succeed. 3. Give fluid nourishment—milk, beef-tea, &c. 4. The headache may be relieved by iced cloths. 5. To relieve the excitement and diminish the tendency to convulsions give to a child 5-grain doses of bromide of potassium dissolved in a little water every three hours; an adult may get 30-grain doses. If recovery should take place, pure milk, cod-liver oil, and sea air will greatly aid it.

If one child out of a family has died of this disease, pains should be taken with the other children to ward it off from them, and unceasing watchfulness for the earliest indication of the affection should be exercised till the child is seven years of age. The children should be permitted no excitements; their studies should be neither long-continued at one time nor severe; they should have early hours, have well-ventilated rooms in some healthy locality, and good nourishment. They should also have a course of cod-liver oil and tonics.

Inflammation of the Brain itself (*Cerebritis*) is not easily, if at all, distinguishable from inflammation of the membranes. Usually both brain and membranes are attacked together.

The **symptoms** are similar to those already described—fever, hard irregular pulse, constipation, sickness and vomiting. There are also severe headache, impatience of light, confusion of thought, and perhaps delirium. These are followed by stupor, dulness of sight and hearing, perhaps squinting, and sometimes convulsions. The disease may begin its course in a

long convulsion, and the convulsive seizures may end in paralysis or deep unconsciousness—**coma** as it is called.

The **treatment** consists largely in administering strong purgative medicines, such as calomel and jalap (see PRESCRIPTIONS). Also for a full-grown man bromide of potassium in 15- to 30-grain doses every five hours, and iodide of potassium in 3-grain doses every four or six hours may be given to diminish if possible the inflammation and excitement. The head should be shaved, and iced cloths applied. Mustard foot-baths are sometimes used; also mustard blisters to nape of neck (the benefit from which is doubtful) and bleeding. The latter should never be employed unless by medical advice. Milk diet is to be given; and if exhaustion sets in strong beef-tea and stimulants of ammonia, wine, or brandy may be required.

Softening of the Brain is sometimes a consequence of inflammation, but is oftener due to want of proper circulation of blood, and is therefore more common in old and feeble people. A frequent way in which a region of the brain may be deprived of its due supply of blood is by a small clot being carried, in the current of blood, from the heart diseased on account of rheumatism. The clot passes along the larger blood-vessels quite safely, but sticks when it reaches the narrower vessels of the brain. It, therefore, blocks the vessel and prevents the blood passing on to that district which the vessel supplied by itself and its branches. The clot which acts thus as a plug is called an **embolus**, and the disease is said to be **embolism**. The region of brain thus deprived of blood becomes soft and breaks down.

The **symptoms** of such a case of sudden occurrence are loss of power of one side of the body—the opposite side to that on which the disease of the brain exists. The loss of power is sudden and without loss of consciousness. Complete or partial recovery may take place. Oftener recovery will not take place, but the intellect gets impaired, and the person childish and feeble, surviving in that condition for some time, and finally becoming unconscious, and death resulting. Softening of the brain may occur more slowly and be accompanied by such signs as weakening of intellectual powers and loss of faculties, depression of spirits, and tendency to weep at any small excitement, pain in the head and giddiness, pain or prickings, and twitchings of the limbs. These may end in sudden paralysis, as already described. Treatment of such disorder is of course impossible. The person must only be kept quiet, and must receive food easy of digestion, costiveness being guarded against.

Dropsy of the Brain is also called **chronic hydrocephalus or chronic water in the head.** (For acute hydrocephalus see previous page.) Its most common forms occur in childhood. The child may be born with the disease, as shown by the very large head, which often hinders delivery, or the disease may arise after birth, generally before the child is six months old. It is due to an increased amount of fluid in the cavities—ventricles, of the brain (see p. 91). Sometimes the disease takes the form of a tumour, attached to the back of the head generally. The cavity of the tumour communicates with the cavities of the brain, and may contain part of the membranes and fluid, or even part of the brain itself. The communication is usually by a small opening in the occipital bone (p. 19).

In the commoner forms there is simply an increasing quantity of fluid in the cavities of the brain. As the fluid increases the head enlarges, specially at the sides and upper parts. The bones of the skull separate from one another, the intervals between them being at first only covered by the scalp. The head may increase enormously so that the child cannot keep it up without supporting it with its hands, the forehead, sides and back all protruding, and the top being flattened. The skin is thinned by stretching, and the blue veins are seen through it. The eyeballs seem to protrude owing to the stretching upwards of the eyebrows and lids, while the face is very small and thin in proportion to the large head, and the body is small and badly developed. The child is liable to convulsions, loss of sight and hearing, and intelligence, while it may become fretful and passionate. Occasionally, however, intelligence remains good. Such children frequently die at birth; they may survive to the second year or later, and die of convulsions or other disease. They may even live to a good age. If they survive, bone forms slowly to fill up the gaps left owing to the separation of the usual cranial bones. In a few cases the disease ceases, and leaves the child with large head and small face, and development otherwise diminished to a greater or less extent.

No **treatment** is of any avail. Strapping the head to prevent it growing, piercing it in safe places to withdraw some of the excess of fluid, and all such practices have been abundantly

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LOCALIZATION OF FUNCTIONS OF THE BRAIN.

This plate is meant to show the situation in the brain of the centres presiding over various movements of the body referred to on pages 102, 103, and 104.

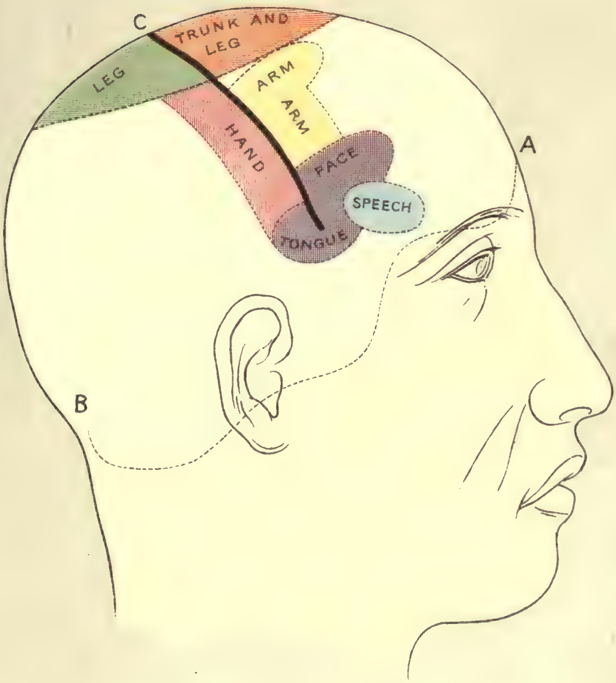
The upper figure is from a cast of the head of an adult male. The scalp has been removed from one side of the head, and also nearly all the bone, arches of bone only being left to retain the brain in place and indicate the position of parts.

F.E. marks what would be the position of the prominent part of bone on the forehead, called the frontal eminence. P.E. indicates the position of the prominent part of the parietal bone on the side of the head, the parietal eminence. R. is the fissure of Rolando, P. the intraparietal fissure, P.O. the external parieto-occipital fissure, S. the fissure of Sylvius, P. parallel fissure, and T. middle temporal fissure. L.S. is the lateral sinus, a channel for the conveyance of blood from the brain to the veins of the neck. This figure, therefore, illustrates how from the outside of the head the position of various regions of the brain can be localized.

The lower figure illustrates the localization from the outside of the head of the situation, in the brain within, of various important centres. A.B., curved line, indicates from the outside the relative depth of the various regions of brain within. C. marks the top of the fissure of Rolando, on each side of which downwards the various centres are situated; and the regions in the convolutions of the brain devoted to movements of various parts of the body are shown.

These diagrams will render plain how the surgeon is guided, in an operation on the brain, in determining at what point to pierce the skull, in order to reach the particular part of the brain, which the symptoms suggest to be disturbed by pressure of a growth, or abscess, or some other removable cause.

FUNCTIONS OF THE BRAIN.



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proved useless. Medicines, too, fail, iodide of potassium, iodide of iron, and mercury, those that might be supposed useful, among the number. The administration thrice daily of 10 grains of a pill made by mixing two parts of crude mercury with one part of fresh squills, and four parts of conserve of roses, has been said to cure some cases when persisted in for some weeks. It may be tried. Failing these probably simple attention to the child's diet, and to the state of its bowels, and the use of cod liver-oil or iron tonics, is as good treatment as any.

Congestion and Anæmia of the Brain.

Congestion or excess of blood to the brain may arise because too much blood comes to the brain, or it may be because, owing to some obstacle, the blood is not permitted to return from the brain with due rapidity and ease. Thus wearing tight things round the neck will hinder the return of blood. Congestion is likely to occur in florid, full-blooded people, given to high living, without sufficient exercise to work it off. *Constant tippling is very likely to produce it.* It may also arise from disease of other organs, especially the liver, heart, and kidneys.

The **symptoms** are a sense of fulness and tightness of the head, flushing of the face, noises in the ears, motes dancing before the eyes, headache, giddiness, sickness, dulness, &c. Even unconsciousness may be produced and convulsions. The symptoms indeed may go on till the condition of **apoplexy** is produced, when the patient becomes drowsy, and finally falls into complete stupor.

Apoplexy may thus be gradually produced or it may arise suddenly, the person falling down powerless and unconscious. When the full apoplectic condition is developed, whether after warning symptoms, like those mentioned above, or suddenly, the person lies totally or partially unconscious, with flaccid muscles, face probably flushed, noisy breathing, pupils of eyes large, and pulse generally full and strong and slower than natural. The motions are often passed involuntarily and urine retained. Sometimes the apoplexy comes on suddenly with paralysis on one side, and then passes on to unconsciousness —coma. In such a case probably blood has passed out of the vessels into the substance of the brain owing to the bursting of a vessel. This is **cerebral hæmorrhage.**

Treatment.—Wherever symptoms like those described under CONGESTION are present the person should guard against excitement, heavy meals, and drinking habits. He should wear loose clothing, and live in a well-ventilated, cool room. He should take moderate daily exercise, and sleep on a mattress with his head high. For medicine he should take some active purgative such as salts, seidlitz, and specially one to act on the liver like podophyllin ($\frac{1}{2}$-grain doses). These might be taken occasionally, and always when headache threatens. The daily morning use of a mineral water like Hunyadi Janos would be beneficial. When a person has been seized with an apopletic fit he should be placed on a firm bed, with head high, in a cool room; his clothing should be loosed, and cold applied to his head either by cold-water cloths, or by ice pounded and put in a bladder on the head. An injection of castor-oil and turpentine, or of salt and water (see ENEMA) should be given. Whether bleeding would be beneficial or not depends on circumstances, and should be determined only by a doctor. If the pulse is feeble and the skin cold and clammy, it would be most hurtful. If recovery takes place give light diet, milk, fish, &c., and let the bowels be kept open.

Anæmia of Brain, or deficient quantity of blood, is the opposite condition to congestion. It may depend on general anæmia (see under DISEASES OF THE BLOOD, p. 234) due to loss of blood or other causes, or may come on suddenly owing to arrest of the heart's action or to bursting of some vessels in the brain.

The **symptoms** vary considerably. Generally they are not unlike those of congestion—headache, constipation, noises in the head, and so on. Insensibility may arise and frequently convulsions. The pale skin, small thready pulse, and sighing breathing, will offer a contrast to the flushed face, full pulse, and noisy breathing of apoplexy, and will help to distinguish between the two.

The **treatment** depends on the cause. If there be loss of blood, that must be stopped. Good nourishing food must be given with moderate quantities of wine. Tonic medicines, especially iron and quinine, and cod-liver oil, are necessary. At the time of attack small quantities of brandy will aid recovery.

Coma, Compression and Concussion of the Brain.

Coma is a state of stupor with loss of consciousness. According to the degree of coma the person may be roused with difficulty, and then he lapses back, or he may not be able to be roused at all. It has been mentioned as

occurring in inflammation of the brain and apoplexy. It also occurs in epilepsy, but there it passes off. It occurs also in disease of the kidney where the urine is suppressed. It occurs also in poisoning from alcohol and opium. The unconsciousness due to apoplexy or injury to the brain, and that caused by drunkenness. are very difficult to distinguish between. *In the cases of persons found lying unconscious in the streets, who are roused with difficulty, the chance of apoplexy or brain injury being the cause ought always to be remembered.*

In **compression** the brain is pressed on, it may be by blood which has escaped from ruptured vessels, as in apoplexy, or by a piece of bone, as in fracture of the skull, or by some body such as a bullet, which may by violence have gained entrance to the brain, or by other agents. The condition produced is similar to the comatose state due to apoplexy with bleeding, and the treatment adopted is the same. (See p. 103.)

In **concussion** or **shock** the brain is shaken, as may occur in a railway accident, for instance, where no apparent injury is done. The shock caused by a high jump or a fall, or a blow, may produce concussion.

Symptoms.—The person becomes suddenly unconscious after the shock and lies motionless. He may be roused to give some short answer to a question, and then he lapses back. In a short time he begins to come round, moves his limbs, perhaps becomes sick and vomits, and then becomes sensible. For a time he remains giddy, confused, and sleepy. In more severe forms the stupor is more profound, the skin is pale and cold, the pupils of the eye wide, the pulse quick and feeble, and the breathing perhaps scarcely perceptible. After recovery has taken place there is danger of inflammation of the brain.

Treatment is directed first to recovery, and second, to prevent subsequent inflammation, or excessive reaction as it is called. To aid recovery, place the patient in bed, *with the head on a level with the chest, not high.* Let warmth be restored by warm clothing, by rubbing the limbs, and, if necessary, by warm applications to the feet. *Stimulants should not be given.* Stimulants are allowable only when no attempt to rally occurs for a considerable time, and the person is still lying with cold, clammy skin and feeble pulse and unable to be roused. When the immediate shock is recovered from, the person should be kept quiet, in a dimly-lighted room, and should receive light diet and opening medicine. These precautions should continue till danger is past. If excitement threatens let a strong purgative be given, and let iced cloths be applied to the head. The person should be watched for several weeks after a severe shock.

Sunstroke and Delirium Tremens.

Sunstroke is an affection attended by engorgement of the blood-vessels of the brain, in which the person who has been exposed to a high temperature is suddenly seized with unconsciousness. It is described in the part on ACCIDENTS and EMERGENCIES.

Delirium Tremens. Delirium is a symptom in many diseases; but delirium tremens arises directly from poisoning by alcoholic drinks. It very often occurs, not during the drinking bout, but after it, sometimes many days after the person has begun entirely to abstain.

The **symptoms** begin with loss of appetite, sickness, constipation of the bowels, and sleeplessness or irregular sleep, disturbed with frightful dreams. Then the tendency to delirium begins to appear in restlessness, suspicion, and tendency to quarrel; the patient is under great dread of something, and extreme tremulousness of his muscles is present. When the delirium is established he is still full of fear and suspicion, searching under the bed and behind curtains for concealed persons; he is talkative and incoherent, but can readily recover himself and talk for a little sensibly, soon yielding again to the delirium. He has hallucinations of sight, smell, and hearing, tries to grasp at things he sees floating or lying before him, or to strike at the insects, animals, or imps that swarm on and round him, mocking and leering at him. The delirium may become maniacal, and he may attack his attendants in his excitement. He may have had no rest for nights, and may have been without food for days. There is generally thirst, but no appetite.

Favourable cases tend to yield of themselves in three or four days, convalescence beginning by a good sleep of many hours. But instead of this favourable result the delirium may go on, and the person become weak, the temperature rise, and convulsions, going on to coma, may end in death.

Treatment.—Place the patient where he can be kept quiet, in a darkened room, free from noise or excitement, and carefully watched. Patients in delirium tremens are sometimes so outrageous and dangerous as to require to be tied down in bed or restrained in other ways;

hence the need of watching. He should have small quantities of nourishing food often, milk, beef-tea, eggs, &c. His bowels should be regulated by saline medicines. Sleep should be procured, and for that purpose 30 grains hydrate of chloral may be given in one dose, to be followed by another dose of 20 grains within an hour, but *only if the first has failed to give sleep.* Without medical advice no further dose should be given till four or six hours later, when, *if necessary*, other 30 grains may be given. But it must be remembered that *chloral requires caution in its use,* so many accidents have arisen in its administration. If chloral cannot be got laudanum may be given; 30 drops for the first dose, a second dose of the same strength in an hour if required, and further doses of 15 drops every two hours, if necessary, for six or eight hours. The patient should be strictly kept from all stimulants. After sleep has been obtained and recovery is begun give quinine and iron tonics.

Dipsomania is a condition to which drunkards are liable, in which there is intense craving for drink, not easy for the victims to resist. It comes on in paroxysms, which may last for days or even weeks, and the paroxysms may recur at long intervals.

Treatment.—The sufferer is not to be regarded merely as a victim to cravings which he cannot resist, and for which he is, therefore, unaccountable. They can be resisted, and are, besides, the direct consequences of his own habits. He should, therefore, be put into conditions as favourable as possible for his aid. He should have good and nourishing but light diet, no highly-seasoned dishes. His bowels should be carefully regulated with saline medicines. Change of air and change of society will do much for him; and this will be aided by an active occupation. Some effort should be taken to keep temptation out of his way. Some medicines are recommended as a substitute for his accustomed stimulant. The following has often proved useful:—

Tincture of Gentian, ... Tincture of Ginger, ...	of each 1 ounce.
Tincture of Cayenne, ...	¼ of an ounce.
Syrup flavoured with Tincture of Orange, ...	1 ounce.
Water, ...	1 ounce. Mix.

Give a tea-spoonful in half a wine-glassful of water when required.

Tincture of the red cinchona bark has been much lauded in America for such cases. It is ordered in tea-spoonful doses, and to each dose 6 drops of tincture of nux vomica may be added.

Insanity.

It is not proposed here to give any detailed account of the nature, causes, symptoms, &c., of insanity or madness. The subject is one of great difficulty, engrossing all the powers and abilities of medical men of eminence who have devoted themselves specially to its study and treatment. It cannot, therefore, be expected that anything but a very general sketch of it can be given in such a work as this, intended for the reading of the general public. What will be attempted here will be to put down, as simply as possible, practical points connected with the causes and signs of insanity, and the general treatment of the insane, which the public ought to make themselves acquainted with. The knowledge of these points may help some to regulate their own or the lives of others in a way to ward off an infliction that may be suspected and dreaded, and may also lead to more proper views of a distressing malady about which, even yet, there are utterly erroneous views and prejudices.

For a long time the insane were regarded as people deserving of being cast outside of the pale of civilization. They were viewed as people who had been singled out by God for the purpose of being branded with marks of his special abhorrence, or as people given over to the power and kingdom of the devil. Society, therefore, could only cast them out from its midst, and humanity could have no feeling for their distresses. No wonder then that they became the victims of horrid cruelty or barbarous neglect. It is not more than fifty years ago since Pinel released in Paris fifty insane who had been for years chained in dungeons. Now, however, general enlightenment, and specially the progress of medicine, have brought about a better state of feeling. It is now recognized that an insane or perverted state of mind is accompanied by and due to an unsound and perverted state of body. A man who suffers from breathlessness, pain, and weakness, owing to an unsound state of lungs, is pitied and cared for. It is admitted that the symptoms from which he suffers are due to a disease in his lungs, the presence of which commends him to our consideration and kindness. The brain is as much a bodily organ as the lungs; feeling, will, intelligence, are as much the functions or duties of the brain, however much more they may be, as are all the functions involved in respiration

the duties of the lungs. Interference with these functions of respiration, diseases preventing their performance or altering and perverting their characters, are regarded as diseases of the lung, and so interference with the intellectual faculties, altered or perverted will or feelings, are to be regarded as diseases of the brain. The man who suffers from lung disease is not regarded as a criminal or degraded, neither should the man who suffers from diseased brain. Both are unfortunate sufferers to be dealt with patiently, and sympathetically, and skilfully, the insane not less but rather more than the consumptive. In all cases of insanity alterations of one kind or another may be found in the tissues of the brain, and these medical science regards as the causes of the disease.

Insanity, then, is a disease of the brain, having for its symptoms enfeeblement, excitement, or derangement of the mental faculties. This departure from the normal state of mind is shown in the speech and conduct, and often in accompanying disturbances of other bodily organs.

It is to be noted that temporary derangement may be present, as excitement or delirium, in fever, or due to the action of poisons like opium, belladonna, henbane, Indian hemp, or alcohol, which are not included under the term insanity.

Also it must be observed that insanity is to be regarded as a *departure from the normal in the individual himself.* One man may have unusual ideas and actions, or his conduct may be unusual from that of his fellowmen, but that need not be insanity. We call him peculiar or eccentric. It is when a man, whose conduct and mode of life up to a particular period have been of the ordinary kind, suddenly or slowly becomes changed in character and disposition (not, it is to be noticed, suiting himself to new circumstances or new views) that his sanity may be questioned. When the cheerful man becomes morose, sullen, desponding, when the kind and gentle becomes harsh and brutal, when the virtuous becomes obscene, and the peaceful becomes violent and turbulent, it is then that there is the departure from the normal of the insane kind.

Now while insanity is a disease of the brain, nay just because it is a disease of the brain, it has causes that may be to some extent understood, and to a large extent guarded against. Even as, to return to our former illustration, a man may have brought on the disease in his lungs we call consumption by his own neglect or folly, so may another by his own acts lay himself open to insanity. The man who, with no great disease-resisting power, catches cold by going about in damp clothes, and then adopts no measures to drive off the attack, but permits it to take firmer and firmer grip of him, is actually responsible should consumption in course of time develop itself. Similarly an individual with a weak or excitable nervous system who indulges in excesses of passion or vice, even in passions that are not in themselves immoral, may become actually responsible for an attack of insanity.

We shall now proceed to discuss briefly in detail the various causes of insanity.

Predisposing Causes. 1. Heredity.—The effects on disease in general of the influence of parents have been already discussed at some length at page 5 and the two following pages. Much of what is written there is directly applicable to the special disease now being discussed, and reference should be made to these pages. Insanity in the parents is one of the most frequent causes of insanity in the offspring. Dr. Maudsley says that at least one-fourth of all the people who so suffer have inherited the disease; and it is said to be more frequently inherited from the mother than from the father, and by the daughters than by the sons. Further, it is not uncommon for insanity in the children to be due to other nervous diseases in the parents. Epilepsy, for instance, in the father may produce insanity in the child. As already observed (p. 6), drunkenness in the parents may be a predisposing cause of madness in the children, probably because constant alcoholic excess seriously deteriorates the brain tissue generally. Frequent intermarriage of close relations, it is well known, has a bad effect upon the offspring. Breeders of animals know full well that they must introduce fresh blood every now and again to maintain the quality of their stock. The same is equally true of the human species. The brain shares in the general bad influence of frequent intermarriage, which thus tends to produce a liability to insanity. The popular prejudice against marriage between full cousins is not without ground.

2. Education is second in importance only to heredity, if indeed second to it, in the consideration of mental disease.

First of all, a mind that is not naturally strong may be marvellously improved by judicious training. It is a physiological rule applicable to the whole body that regular exercise, followed by equally and regular stated periods of

repose, promotes the activity and health of the tissues, and if regular and not excessive, increases their strength and efficiency. It is the regular and yet not excessive exercise that the blacksmith's arm receives that produces such brawny well-developed muscles. It is a second rule, equally applicable to all the tissues, that want of use is shortly accompanied by degeneration, and perhaps finally complete decay. The arm that is kept tied up for weeks without exercise because of fracture, when taken down has lost much flesh, is thin, and weak. Finally, youth is the time when such regular exercise is capable of stimulating to greatest strength and development. Now all these rules applied to brain mean that a faculty, whether it be of observation or of memory, of self-restraint or of will, of imagination or of reason, which receives this early, regular, and careful exercise, is stimulated to growth, and increased in strength. Hence, careful training may do much to ward off degeneration from a naturally weak nervous organization. The reverse is equally true, that want of training may not only leave the weak brain an easy prey to disease, but may actually cause it to grow weaker, and so become a more easy victim.

Secondly, the kind of training may directly excite the disease to the attack. Repression, harshness, and cruelty, excessive mental exercise, compelling children to cram too many lessons, or, on the other hand, want of control over children, yielding to their every desire, and letting them yield to their angry fits or tempers, all these are injurious. Deep impressions made on children's minds by terrifying stories or sudden frights, will have similar bad effects.

3. The **sex** does not seem to have any important influence on the disease.

4. In regard to **age** it is only necessary to remark that, while no age is exempt, insanity is commonest between the ages of twenty-five and fifty, probably because it is between these years that labours, worries, and anxieties are greatest in number and intensity.

5. **Social Condition.**—It seems that the married relationship tends to preserve health and sanity. Among the insane there are more single than married people.

Exciting Causes.—These are generally classified as **moral** and **physical.**

1. The **Moral** causes of insanity are such as vexation, grief, or anxiety. Emotions, and depressing emotions specially, are causes. Jealousy, unrequited love, distress at loss of fortune or friends, or failure in the objects of ambition, the anxiety caused by heavy responsibilities, religious excitement, or depression, and such as these, are the exciting causes of the change. Intellectual labour, pure and simple, and joyful emotions, rarely produce it.

2. The **Physical** causes include those that act upon the general system, such as injuries or diseases. Various diseases of the brain and spinal cord, and even diseases of lungs, liver, kidneys, and other organs, gout, epilepsy, and so on, are capable of producing the affection. Exciting causes of great importance are found in women in connection with menstruation and the period of its cessation, and with pregnancy and delivery. Excesses in drink, in drugs like opium, as well as sexual excesses, are among the commonest of exciting causes.

General Symptoms of Insanity.—Probably the first thing noticed about a person whose mind is becoming affected is some change in the state of feeling, some depression or elevation of feeling. Under this change the person becomes restless, morose, sad, mirthless, indifferent, irritable, or reckless and extravagantly joyous and merry. Under the operation of the disease the person's moral nature may become perverted, so that he is untruthful and dishonest, vicious or immoral. The moral perversion may be so great as to lead to yielding to some wild impulse or fury that ends in violent or murderous acts. It must be again noted that the former character of the patient is the standard by which his present, supposed insane, conduct is to be judged.

Further, some faculty of mind becomes impaired, memory often and reason, though frequently the quite insane person will argue with apparent smartness and ready wit. The intellectual disorder may show itself in slowness of thought and incoherence of speech. Will also becomes perverted, so that the person is weak and fickle, or stubborn and perverse. Thus some insane patients have the delusion that they are acting under the will of some other whose commands, no matter what they be, they are bound to obey, so that they are impelled by impulses whose time and direction cannot be reckoned on.

A common symptom of insanity is the existence of illusions and hallucinations. The term "illusions" is applied when the patient sees some object actually before his eyes, but, under the influence of his diseased brain, the object becomes transformed to him into something quite different from what it actually is. Thus

shadows are taken for fiends or wild beasts, dust becomes grains of gold, pebbles become diamonds. In the same way all his senses may cheat him; a noise may be a voice speaking to him, the wind may whisper evil things to him, and so on. But when a person sees something when there is nothing to correspond to it externally, when he hears a voice and there is no sound even to explain his imagination, that is, when there is nothing affecting the senses from without to give occasion for the diseased imagination, the person is said to be the victim of a "hallucination." Often these hallucinations govern the person's life to a great extent. He sees figures beckoning him onwards, and he must follow; friends long dead throng round him; voices command him, and he must obey though they incite to murder. Thus tendencies to suicide and murder are often due to such hallucinations. "Delusions," again, are false ideas originated by the disease in the person's mind, such as that his head is made of glass, that he is heir to the throne, &c. Besides these disturbances of feeling, intelligence, will, and sense, there are such affections as paralysis, epilepsy, catalepsy, convulsions, and others, to which the insane are liable.

Kinds of Insanity. — Six general types or kinds of insanity are usually described, namely, **Melancholia, Mania, Monomania, Dementia, Idiocy,** and **General Paralysis of the Insane.** It is not meant that these are different forms of insanity absolutely marked off from one another, for all the forms merge into one another. According to the main features of the disease, as exhibited in a particular person, is it put into one or other of these classes. These main features or general characters will now be briefly described. Very many cases of all kinds begin by manifestations of altered feelings, generally feelings of a depressed and sorrowful character. The symptoms that lead to the person being classed as melancholic or maniacal, &c., develop afterwards.

1. **Melancholia,** or Morbid Depression of Spirits.—In this form the depression of spirits is great, and may lead to the person withdrawing from society, and even from his dearest friends. All things and persons become repugnant to him. He is irritable, morose, and suspicious. He is often the victim of delusions or hallucinations—people are watching him, whispering about him, plotting against him; the world is ruined and he is doomed; or he is bewitched, possessed, magnetized. Such are the delusions which affect him. Sometimes the person imagines part of his body is made of glass, or has similar absurd notions.

As a result of all this misery the tendency to suicide is almost inevitable.

Melancholia may lead to attacks of mania, or of excitement bordering on it. Half of such cases recover in the end, though a relapse is to be feared. Recovery, which is usually gradual, is to be looked for within six or twelve months, and need not be expected after that time.

Hypochondriasis is a form of melancholia in which the person believes himself to be suffering from serious illness. He is troubled with all sorts of complaints, which he is constantly discussing, watching, and seeking treatment for.

2. **Mania,** or Morbid Excitement, may break out suddenly, but usually follows a period of depression like that of melancholia. At length, and perhaps by slow stages, the depression yields to excitement, displayed by quickness and loudness of speech, readiness to laughter or anger, and incessant bodily activity. The activity may find vent in shouting, leaping, &c., may show itself by a sort of intellectual elevation, sparkling or witty speech and conversation, humorous sallies, or may be of a degraded sort, displaying itself by cursing, swearing, violence and assault, or acts of shame and wantonness. Sleep is often diminished, and the state of restless activity may continue for days and nights without apparent fatigue of the patient. Delusions and hallucinations are present here also, but they have not the settled hold characteristic of melancholia. Under their influence, however, the maniac may believe himself to be some great warrior or captain, or to be capable of some superhuman feats, and so on.

Maniacal attacks are apt to be periodic, the return of the mania being in women determined frequently by the menstrual period. Mania is often alternated with melancholia.

Recovery is generally slow, though it may be sudden, and occurs most frequently within a year. After the end of the second year the case is nearly hopeless. If recovery do not take place the mania may become chronic, or may pass into dementia, unless death is caused by other disease, or by violence at the person's own hands.

3. **Monomania** is the form of insanity in which the person is possessed by some fixed idea. Frequently, apart from the particular idea, the person seems perfectly sane and intelligent, and no mental disorder is noted until the particular idea comes up. Sometimes also monomaniacs seem to avoid the delusion which affects

them. The delusion may be of any kind. The person may imagine himself to be some emperor, statesman, orator, or poet. Under the influence of the dominating idea the person puts on airs suited to the character he is supposed to be, haughty and arrogant, or affable and condescending. The delusion may be of a low form, and is manifested by moods suited to it. The person may imagine he is peculiarly constructed, and certain precautions must be taken with him. Thus he may suppose his head to be made of glass, &c. Monomania has less chance of cure than mania.

4. **Dementia** is characterized by feebleness of mind. It is, in fact, enfeeblement of mind. It is the result of incurable melancholy or mania, and follows diseases like softening of the brain and long indulgence in drink. It may be merely an accompaniment of old age. In dementia there is not only intellectual but moral feebleness. The person is not only silly, weak, childish, but has no depth of feeling, is indifferent, and cares for nothing. Memory is also impaired. While, however, the things of yesterday are entirely forgotten, the events of early life may throng up and the person live in the past, as it were, calling the persons round him by the names of those he knew in youth, who have been long dead or absent. Demented persons often busy themselves with curious occupations. They usually live for many years, and enjoy good health, appetite, and sleep.

5. **Idiocy** is a condition of absence of intellect which dates from birth. It is often a consequence of too close intermarriage, or of drunkenness on the part of the parents. It may be occasioned during infancy by epilepsy, or by injuries to the brain, or by some severe strain or fright.

Idiots have a vacant expression of countenance, small and misshapen head, awkward walk, and are liable to sudden changes of temper and outbreaks of spiteful anger. Speech is, as a rule, imperfect, and in one class of idiots is entirely absent. Idiocy is frequently accompanied by dulness of hearing.

Idiots are incurable, but capable of great improvement by careful training, and may be made in a way useful and happy.

6. **General Paralysis of the Insane** has many symptoms similar to those described under the various other forms of insanity, but has besides as a special feature paralysis which slowly extends till it affects all the voluntary muscles. Slowly creeping paralysis may be the first symptom of the disease, paralysis which begins with loss of muscular power. The patient begins to speak indistinctly; his lips and tongue tremble when he speaks, so that his utterance is tremulous; his hands tremble when he tries to use them, his legs when he tries to walk, so that he totters and stumbles. It may not be till these symptoms have considerably advanced that signs of insanity appear, signs of mental excitement, of delirium, of delusions, or it may be signs similar to those described under melancholia. It may be that the disease begins with melancholy excitement or fits, and that the paralysis does not appear till later. However it be, in the end the person's mind becomes so enfeebled that intelligence and memory have almost disappeared, and he sinks into the condition of dementia, while the paralysis may be so extreme that he cannot walk, dress or undress, or feed himself, without aid, and may even have difficulty in swallowing, has no control over his bowels or bladder, and loses power also of feeling.

This disease is practically incurable.

Death usually occurs within three years of the commencement of the disease, death from apopletic convulsions, or from suffocation from the defect of swallowing allowing food to get into the windpipe, or from exhaustion.

Other forms of insanity exist, such as **puerperal insanity**, that is, the insanity attending pregnancy, childbirth, and nursing, and insanity attending menstruation, which are described under DISEASES OF WOMEN. The insanity of **delirium tremens** has been already described (p. 104). Besides, there is a form of insanity due to self-abuse, accompanied by weak-mindedness, indecision, delusions, and hypochondriasis.

General Treatment.—It has been remarked that idiocy, dementia, and general paralysis of the insane are practically incurable, so that all the treatment can consist only of general care and supervision of the unfortunate sufferers. This implies careful selection of appropriate food, regulation of the bowels, regulation also of hours devoted to sleep, to exercise, so far as the patient can engage in it, to work may be, or recreation. It has been already said that idiots are capable of great improvement by judicious and constant training. Besides this kind of supervision there is also in such cases a large amount of restraint necessary, moral restraint to control fits of anger, spite, or excess in various other directions, and physical to prevent outbursts of violence that might be dangerous to the patient or others. The best place for such treatment is undoubtedly an asylum. Of course

there are many cases of idiots who, if the circumstances of the friends permitted it, might be as well treated at home.

As to other forms of insanity, the question of treatment in a private home or in an asylum depends on the nature of the case and chance of recovery. When the mental disturbance has been caused by pressure of troubles or by excesses in drink, or immorality, and where lapse of time has not confirmed the disease, the best treatment consists in total change of circumstances. The business man must be freed from his business worries, the literary man from his books; or, if the insanity has been caused by loss of friends, disappointments, or failures, only change of circumstances, with abundant external attractions in the shape of new acquaintances, new occupations, new surroundings, is capable of diverting the mind from its morbid dwelling upon itself, and of driving from the memory old and sad associations. This may be effected, if the patient's means can afford it, by intrusting the person to some skilled keeper, under whose charge he may be permitted to travel, or by sending the person to some private home at the seaside or in the country kept by a properly qualified medical man.

Some cases manifestly must go to an asylum, such as cases of mania, cases where suicide is possible, or where violent outbursts might lead to murderous attacks, cases, in short, of mania, monomania, and melancholia of pronounced character.

It may be observed that cases of insanity affecting women, often young women, and associated with sexual functions, cases with a strong element of hysteria, can never be properly treated by the patient's friends. They require firm control, while the patient's friends invariably find themselves unable to resist the thousand and one whims and caprices which are so perplexing an element in such cases. Frequently such cases, curable at first by proper control, become hopeless from the difficulty of proper management in the patient's own home, owing to the leniency and affectionate but *unwise* solicitude of friends.

The Prevention of Insanity is for the public a much more important question than its treatment. Parents, guardians, and individuals can wield here a great influence, if they only know how. *First of all*, all parents and guardians should so nourish, train, and educate children of whom they have the care, so as to develop to the utmost their strength of body and soundness of mind. *Secondly*, parents and guardians should take special precautions in the rearing of children, any of whose relatives in a direct line have shown tendencies to, or have been actually affected by, insanity. *Thirdly*, individuals who are of an age to regulate their own lives, ought to beware of excesses likely to lead to nervous exhaustion or degeneration, and, where a bad tendency exists in the family ought to, if possible, so frame their lives as regards business, amusements, and other pursuits as to secure a calm and equable frame of mind, free from sudden strains or strong excitements.

As regards the duties of parents and guardians, it is to be feared that the extent to which oversight is demanded is not properly realized. It involves attention to diet, to clothing, to exercise; it should have strict regard to the due proportion of work and play, study and amusement, and not that only, but also the kind of work and play, the species of study, and sort of amusement. Among the better classes the tendency is to leave a good deal at home in the hands of upper servants and nurses, and to leave the education of the child entirely in the hands of the masters at school. The result is, that at school the child is carried on with the rest in its class, it being impossible for a master at school to deal with individual peculiarities in a large class, and at home the child is at the mercy of servants, a large number of whom certainly are actuated by good motives, and exercise their power to the advantage of the child, but some of whom may obtain obedience by threats and rule by fear. Many children owe a nervous disposition and unstable mind to terrors produced by tales told by its nurse, or by being left in a dark nursery for hours alone, and in other similar ways. For like reasons the influence of companions must be watched. Among the poorer classes it is not an uncommon spectacle to see the eldest of a large family of little ones, herself quite young, being compelled, in order to help her mother (!), to assume herself the cares of a mother, and to be responsible for the other children. In these days education worries are not limited to the children of the rich. In Great Britain the operation of the School Boards is limited to no class, and under the code system a scientific species of cram is taking the place of education. Large classes of children are taught together—taught in bulk—all to come up to one standard, as if they were all made in one mould. For months before the annual inspection a suppressed excitement

affects teachers and scholars, and a strain is endured, than which nothing can be more trying to growing nerve tissue. Under this system the weak must suffer. Parents, therefore, must not think that state regulation of education relieves them of responsibility. It only increases the responsibility. The responsibility of the state is for the mass, the responsibility of the parent is for the individual child. It becomes, therefore, the urgent duty of parents to watch their children, and if the fear of undue pressure at school arise, to seek the opinion of a physician, and if so advised to get the child relieved from some of its burden of lessons. Another thing to which parents ought to give their attention is the school hours. It is not an infrequent thing for children to be engaged at school from 9 a.m. to 3 or 4 p.m., with no sufficiently long interval in which to go home and get dinner without undue haste. This means breakfast before nine and dinner about four, hunger in the interval being staved off by bread and butter. Thus with overworked brains and under-supplied stomachs, the children are fit subjects for nervous or any other disease.

Special care must be given to children in whom there is a probability of hereditary disease. In particular, they ought to be kept under a wise control, and trained to a proper self-control, so that angry fits and passions are subdued and held in check. With them education may be all powerful, if badly directed, to hasten the development of the disease, if prudently conducted to strengthen and develop what may be naturally weak.

Individuals who guide their own lives, and have in view the fact that madness has been in their family, and that therefore for them it may be a prospect, or who, for other reasons, fear its advent, should face the risk. If they do so boldly, they will choose occupations and engage in amusements that are unexciting in character; they will avoid excess of all kinds, and especially avoid indulgence in strong drinks and animal passions, and will find means for quiet but profitable occupation in leisure hours.

Headache and Giddiness.

Headache (*Cephalalgia*) is extremely common, and is of so many different kinds and arising from so many different causes that one treatment for all is impossible.

It may be a symptom of a disease, rather than a disease in itself. For example, it is one of the commonest and most painful symptoms in *disease of the brain* and its membranes; headache, giddiness, and vomiting are early symptoms in affection of the brain owing to *disease of the ear* (see p. 100), and it is usual in fevers and other acute diseases. Further, it is a result of improper conditions of the blood—*poverty of blood*, or when the blood is impure owing to *rheumatic or gouty affections*, or owing to *disease of the kidneys*. In fact, headache may be a mere accident, or rather accompaniment, of other diseases, which must be attacked before the headache will be relieved. One of these diseases—*Syphilis*—deserves special attention. The headache due to syphilis, contracted perhaps years before, is of a most painful and persistent character. It has often lasted for weeks and brought the patient to the verge of suicide. The treatment for it is undoubtedly large doses of Iodide of Potassium, but the drug must be given with certain precautions, for which see under SYPHILIS.

In *disorders of digestion*, and specially connected with the liver, headache is generally so prominent a symptom as to be counted almost the real trouble, and hence is called **bilious headache**. It is usually of an intense character, throbbing or bursting and soon accompanied by sickness. If vomiting occurs, the nausea is generally relieved, and the headache then yields to sleep. Often the vomiting does not occur, and hence the popular resort to a glass of warm water with a large tea-spoonful of mustard stirred in it in order to induce vomiting. This treatment may be adopted, and often relieves so quickly that sleep is induced and completes the cure so far as the headache is concerned.

Constipation is another frequent trouble producing headache. To relieve it as well as to unload the liver, a blue-pill at night, followed in the morning by a strong seidlitz-powder, is very useful. People troubled with such disordered digestive organs will find the daily or at least frequent use, in the morning before breakfast, of mild opening medicine like Hunyadi Janos mineral water (a wine-glassful), Eno's Fruit Salt, or other saline purgative, of great value. Where *flatulence* is conjoined with constipation a teaspoonful of Aromatic Spirits of Ammonia in a glass of water is often beneficial.

Decayed Teeth must not be forgotten as not infrequent producers of headache.

In women, as might be expected, disease of the womb is a common cause.

Arsenical poisoning is accompanied by intense headache. Other symptoms go along with it—sickness, griping pains, depression. Now one

of the prettiest green colours is made with arsenic, and this colouring matter is frequently used for wall-papers. The heat produced by a fire in the room will readily cause the arsenic to come out of the wall-paper, so coloured, in invisible vapour, which the persons sitting in the room will inhale. They may, therefore, suffer from the above-mentioned symptoms. Thus some persons have been accustomed to be plagued with headaches and nausea when they rose in the mornings during the winter months, and when they went away for a short holiday, or with the advent of summer, the headaches disappeared. Careful inquiry has found the cause in their bed-room paper. They used fires in winter which brought out the arsenic, and so the persons rose in the morning unrefreshed after inhaling arsenical vapours during the night. With the arrival of summer the fires were left off, the arsenic was not vaporized, and the symptoms disappeared. Similarly others have been afflicted with headache after sitting some hours in their drawing-room, or some particular sitting-room or study. Therefore all who are similarly troubled should examine any green papers that may be on their walls; *and no householder should permit a green paper to be put on a wall in his house, unless a chemist has certified it to be free from arsenic. Let him not trust the painter or the seller of the paper.*

Apart, however, from affections like these, in which it is mainly an indication of the real disease, headache may be almost or actually an affection in itself.

Of this sort three main types may be taken.

I. *Headache due to congestion* of blood-vessels in the brain, that is, to too much blood in the brain. This is the *congestive* or *plethoric headache.* It is attended with throbbing blood-vessels, is of a heavy dull sort, often accompanied with giddiness, and liable especially to attack full-blooded people who live well and take too little exercise. In women it will tend to occur if the monthly periods be insufficient or suppressed.

II. *Headache due to too little blood in the brain* is the opposite of the above, and is called the **anæmic** headache. Pale, weak girls who suffer from excessive regular discharge, mothers exhausted by nursing, the badly fed and ill nourished, are liable to this form. Besides, these conditions may quickly arise in people in ordinary health, producing this anæmic condition of the brain, lasting for a short time, and exciting a headache. It is well known that during sleep the brain has a much smaller blood-supply than in waking hours, and it may well be that the headache that many people experience, if they sleep beyond their usual time, is due to this condition too much prolonged. The anæmic variety is accompanied by listlessness, indisposition to usual work, and so on.

III. *The nervous headache* is perhaps commoner than any. It will come on from many causes; loud noises, slight excitements, will readily provoke it in some. Teachers seem peculiarly liable to it. The studious, and those who work with their brains, so to speak, find it a frequent companion. "Thunder in the air" is often said to provoke it. Fatigue, such as ladies undergo during "shopping," late study, business worry, all these are inseparably linked to it. A form of the nervous headache is called **megrim** or **brow ague.** It particularly affects delicate women, in whom fatigue, confined hot rooms, or errors in diet speedily excite it. It is an aching pain, attended often by sudden shooting pains, and throbbing vessels. Beginning dull, it gradually becomes intense, becomes intolerable by movement, gives rise to an intense nausea, which may occasion vomiting, and terminates in sleep. It is curiously enough hereditary, and comes on, in those afflicted with it, at regular intervals. Disorders of sight and speech sometimes attend it.

Under the nervous variety may be classed the *neuralgic headache.* The slightest exposure to cold may bring it on. The pain of it is frequently of a shooting character, and it often comes on regularly at a particular time of day or night.

Treatment.—*For the congestive variety* a good purgative medicine is desirable,—rhubarb and magnesia, Gregory's powder, aloes-pill, seidlitz-powder, &c., with regulation of diet, which should be plain, exercise, and fresh air. A good meal has cured many a headache. It may be that, the person having long fasted, the blood has "gone to the head," since there is no work for it to do in the digestive organs, which in fasting are always pale. As soon as the person has taken a good meal the blood rushes down to the stomach and bowels to supply means for their activity; and so the headache is relieved. In such a case of course the long fast indicates the remedy.

For the anæmic variety, good food, iron tonic (see PRESCRIPTIONS), and similar means of getting up the system are obviously required.

For the nervous headache a great variety of medicines has been recommended. The really

nervous form is often greatly benefited by nerve tonics, and specially by phosphorus. To teachers and studious people this may specially be recommended. The writer has known cases of teachers to whom nervous headache was a perfect plague, who could scarcely teach for two or three hours without its appearance, and to whom phosphorus in pill was a great boon. The best way to obtain it is in pill. These pills may now be obtained all over the world,—either Richardson's pill or M'Kesson & Robbins (New York). The quantity of phosphorus in each pill should be $\frac{1}{50}$th to $\frac{1}{30}$th of a grain, and may be obtained alone in the pill, or combined with iron (2 grs.), nux vomica ($\frac{1}{8}$ to $\frac{1}{6}$ gr.), and quinine ($\frac{1}{2}$ to 1 gr.). The latter combination is good for people needing general strengthening. The same makers put up a pill very useful for females, of phosphorus ($\frac{1}{50}$th gr.) and valerianate of zinc (1 gr.).

For *megrim* a good and safe remedy is bromide of potassium, 30 grs. in a wine-glassful of water. A remedy recently used and of great value is the effervescing citrate of caffein, of which one tea-spoonful may be taken in a wine-glassful of water every hour for several doses. In America guarana (Brazilian cocoa) has been much used in 15-grain doses. Chloride of ammonium (sal ammoniac), in doses of from thirty to forty grains in milk three or four times a day, is a favourite remedy with some.

As a preventive a mineral water like Hunyadi Janos every morning, or fruit salt, or even a tumbler of common salt and water, is strongly advised. The use of strong tea, coffee, or tobacco should be discontinued.

For the *neuralgic headache* nothing is more valuable than a powder containing 5 grains of quinine and 20 grains of salicylate of soda, taken in water, once in twenty-four hours.

During the attack the person should be kept quiet in a darkened room, with head raised, and the frequent application of iced cloths made use of.

Vertigo (giddiness, swimming in the head) is a sense of things whirling round, and may pass off speedily, or may cause the patient to stagger and fall.

It is a symptom rather than a disease. It accompanies disease of the brain, and a special disease of inner parts of the ear (Ménière's Disease). Sometimes it is a mere indication of a passing disturbance in the circulation of the blood in the brain, sometimes the result of an unhealthy condition of the blood. It may be almost the only symptom in mild cases of epilepsy. It also is very often dependent upon digestive disorder, and *will very often be found to be due in women of the working-classes, and girls kept busy all day in warehouses, to excessive tea-drinking, want of regular nourishing diet, and consequent indigestion and flatulence.* Women are also subject to it at the monthly periods, and on the occasion of any sudden stoppage of them, or during "the change of life."

The use of opium, and excess in alcohol, or specially tobacco, will produce it.

The treatment is indicated by the cause. Set the indigestion or flatulence right, and attend to the functions. If flushings of the face accompany it and indicate congestion, use purgative medicines, mineral waters, wholesome but not too rich diet, and exercise. Cease excess in drugs or tobacco. If the symptoms seem to indicate a more serious cause, only a physician is capable of arriving at the truth.

Somnambulism, Sleeplessness and Nightmare.

One of the characteristics of all living things is their *periodicity*. Thus plants have their period of activity, culminating in the production of flower and fruit, and their period of inactivity during which they appear quite without life and sap. Not only have they their annual periods of activity and inactivity, but also daily periods, their alternations being so largely dependent upon light and heat. Thus while ordinary flowers flourish mainly during the daytime, the night-flowering cactus blooms and emits its perfume during the night. Animals also exhibit this periodic character. Most notable examples are the hybernating animals, who with the coming of winter's cold are subject to a remarkable diminution of their bodily processes, so that they pass the winter in a condition of unconsciousness, waste being reduced to the lowest, and the bodily function being just performed sufficiently to maintain the spark of life, which the return of heat reanimates into a flame. Human beings also present many instances of a periodic character. The chief is undoubtedly exhibited by the heart. This organ might seem at first to be perpetually active during the whole of a person's lifetime; but it is not so. The movement of the heart is rhythmic, the rhythm consisting in regularly alternating periods of work and of rest. Thus, at the close of each contraction of the heart, signified by the

beat against the chest wall, there is a pause, and the period of contraction is in the proportion of $\frac{3}{5}$ths to that of the rest, which is $\frac{2}{5}$ths; the heart, that is to say, works $\frac{3}{5}$ths of its time and rests $\frac{2}{5}$ths. Similarly after every expiration from the lungs there is a pause before the next inspiration begins. These periods of rest are necessary for the continued vigour of the organs. The heart that was kept in such a state of excitement that it had little or no intervals between its contractions would be speedily exhausted, and would require to cease its work altogether. It is undoubtedly during the periods of repose that the energy expended in the immediately preceding activity is mainly renewed, and consequently, if, through want of the repose, the needed replenishment of energy did not take place, exhaustion would speedily follow. Now sleep is just another manifestation of this periodic character of living processes. Sleep affords the interval during which nervous energy expended during the waking hours is renewed. In the waking state the mind is being constantly appealed to. From all sides, by means specially of eye, ear, nose, and other sense organs, demands are made upon the attention of the brain, and during this waking state there cannot be a moment when the mind is not occupied somehow or other. All this means expenditure of force, and consequent waste, which must be repaired. There, therefore, comes a time when this expenditure has reached a point when it is of advantage that it should cease, and the desire for sleep arises. The desire may, however, be fought and the activity of the brain continued *by demand. This activity by demand* means a greater than usual expenditure of nerve-force, a greater than usual degree, that is, of nervous exhaustion. But it is obvious that the time will speedily come, be the stimulus what it may, when the cells that are the source of the energy can no longer respond to the demand, and sleep will supervene, no matter how resolutely it may be resisted, and no matter what objects are brought before the mind with a view to maintain its attention. Remarkable instances of this fact are given, such as those of gunner boys falling asleep during the height of an action, owing to the fatigue caused by their labours in carrying ammunition for the gunner. A case is also reported of a captain of a warship, engaged in the last attack upon Rangoon, falling asleep, and remaining so for two hours beside one of the largest guns of his ship, the gun being served vigorously all the time. Instead of sleep supervening, however, it often happens that, when sleep has been kept off by great mental effort or strain for a considerable time, a condition of irritability is set up which prevents the access of sleep when it is at length desired. Business men, literary men, students, who night after night occupy themselves with business cares or studies far beyond the usual hour of retiring, are apt at length to produce a condition of extreme excitability and restlessness, which prevents them going to sleep without delay when at last they do retire, and which prevents the sleep being either refreshing or restoring. This is properly an abnormal condition, a condition upon the very borders of disease, if not actually disease. It indicates the revolt of the nervous centres to the treatment they have received, a revolt which may pass into something very much worse if the cause of it be not speedily done away with.

It has been said that during our waking hours the mind is kept incessantly active by the demands made on it through the senses. Naturally, therefore, sleep is most readily obtained when the avenues of sense are closed, so that the mind is cut off from the distractions that throng upon it. Thus the closing of the eyes, and darkness, cut off distractions conveyed by the organs of sight, and with silence the ear is powerless to stimulate. It is recorded of a boy who had only one eye and one ear that were of any use, and who, owing to disease, was otherwise insensible to impressions from without, that the closing of his eye and the blocking up of his ear speedily put him to sleep.

The condition of the brain during sleep is one of considerable bloodlessness. There seems to be both a diminished quantity of blood circulation through the brain, and the speed of its movement is lessened; whether this is the cause of sleep, or is the result of diminished activity of the organ—less demand and consequently less supply—it is difficult to say. Probably it is rather an effect than a cause of sleep.

In sleep, then, the mind is cut off from the outside world. The question has arisen whether this is all, or whether sleep implies not only the interruption to the conveyance of stimuli to the mind by the avenues of sense, but also interruption to the activity of the mind itself. In a word, does the mind sleep too, or does it wake? On the answer to this question depends the explanation given of many very complicated and interesting facts, such as those of dreaming and somnambulism. Many maintain that the mind is quite inactive during sleep, when the sleep is good. If the mind is quite inactive during

ordinary profound sleep, there can, of course, be no dreaming, since that implies an activity of the mind. So those who believe profound sleep to mean complete mental inaction, believe dreaming to be the mark of imperfect sleep, and to occur, therefore, when sleep is light, and specially in the stage between sleeping and waking. The main feature of dreaming is that however active the mind may be the will is in abeyance, and ideas and imaginations throng through the mind without let or hindrance in uncontrolled disorder. They are ideas with which the mind has been previously occupied, and which come up perhaps accompanied with their old associates, perhaps with other old ideas, not, however, formerly associated with them. They are frequently suggested by external circumstances, a sound setting up a rapid train of ideas which rushes across the mind in the interval before the person is awakened by it. Or the suggestion may come from within—the pains of indigestion setting up dreams of terror, coldness of some part of the body suggesting to the sleeper that he has fallen into the water, and so on. Nevertheless it has happened that intellectual processes of a high order have been carried on in dreams. Opposed to the view that the state of mind during sleep is one of inaction, is that view which holds that the mind is always active, and that in sleep we are always dreaming, but that we do not remember our dreams unless we awake in the middle of them. It is the memory that is defective and fails to recall our dreams. This view offers a simple explanation of dreaming and of somnambulism.

Somnambulism is distinguished from dreaming by the fact that while a person may recall his dreams, the somnambulist has no recollection of anything said or done during sleep. Somnambulism may be in the very simple form of talking in the sleep, or may amount to getting up, walking about (this is what the word implies—sleep-walking), and engaging in various kinds of activity. Cases are recorded of men rising in sleep, dressing, and going out to their workshops or offices, of mathematicians working out obscure problems which had baffled them when awake, of lawyers writing out just and accurate opinions on difficult and intricate points of law, concerning which they had been unable when awake to form a decision, of poets writing some of their most delightful verses, of musicians composing their most successful pieces, and of people discovering property that had been long lost or mislaid past finding. The credibility of such feats is denied by some eminent men, and yet instances are given of such things being done. More than that, there are credible records of as marvellous feats being performed by persons who developed their power during attacks of madness, and of people displaying, during attacks of delirium due to fever, powers formerly unknown to themselves, and powers they no longer possessed when the delirium had passed. Thus Dr. Rush, an American physician, has recorded of a female patient of his who became insane after child-birth, in the year 1807, that she "sang hymns and songs of her own composition during the latter stage of her illness with a tone of voice so soft and pleasant that I hung upon it with delight every time I visited her. She had never discovered a talent for poetry or music in any previous part of her life. Two instances of a talent for drawing," he adds, "evolved by madness, have occurred within my knowledge." Coleridge in his *Biographia Literaria* (p. 54, ed. 1870) relates the following case, which "occurred in a Catholic town in Germany a year or two before my arrival in Göttingen, and had not ceased then to be a frequent subject of conversation. A young woman of four or five and twenty, who could neither read nor write, was seized with a nervous fever, during which, according to the asseverations of all the priests and monks of the neighbourhood, she became possessed, and, as it appeared, by a very learned devil. She continued incessantly talking Latin, Greek, and Hebrew in very pompous tones, and with most distinct enunciation. . . . The case had attracted the particular attention of a young physician, and by his statement many eminent physiologists and psychologists visited the town and cross-examined the case on the spot. Sheets full of her ravings were taken down from her own mouth, and were found to consist of sentences, coherent and intelligible each for itself, but with little or no connection with each other. Of the Hebrew a small portion only could be traced to the Bible; the remainder seemed to be in the Rabbinical dialect. All trick or conspiracy was out of the question. Not only had the young woman ever been a harmless, simple creature, but she was evidently labouring under a nervous fever. In the town in which she had been resident for many years as a servant in different families, no solution presented itself. The young physician, however, determined to trace her past life step by step; for the patient

herself was incapable of returning a rational answer. He at length succeeded in discovering the place where her parents had lived; travelled thither, found them dead, but an uncle surviving, and from him learned that the patient had been charitably taken by an old Protestant pastor at nine years old, and had remained with him some years, even till the old man's death. Of this pastor the uncle knew nothing but that he was a very good man. With great difficulty, and after much search, our young medical philosopher discovered a niece of the pastor's, who had lived with him as his housekeeper, and had inherited his effects. She remembered the girl; related that her venerable uncle had been too indulgent, and could not bear to hear the girl scolded; that she was willing to have kept her, but that after her patron's death the girl herself refused to stay. Anxious inquiries were then, of course, made concerning the pastor's habits; and the solution of the phenomenon was soon obtained. For it appeared that it had been the old man's custom for years to walk up and down a passage of his house, into which the kitchen door opened, and to read to himself with a loud voice out of his favourite books. A considerable number of these were still in the niece's possession. She added that he was a very learned man, and a great Hebraist. Among the books were found a collection of Rabbinical writings, together with several of the Greek and Latin fathers; and the physician succeeded in identifying so many passages with those taken down at the young woman's bedside, that no doubt could remain in any rational mind concerning the true origin of the impressions made on her nervous system."

Dr. Abercrombie relates cases where attacks of somnambulism came on, not during night, but during daytime. During the attack—which lasted some time, then passed off, and at some later period returned—during the attack the persons were abstracted, and could do what was impossible to them after the attack passed off. One patient was an educated young lady, who, on recovering from her first attack, found she had lost all her former knowledge, and set to work to regain it. She was making progress when she was seized with a second, which left her with her former state of knowledge quite restored. This alternation went on for four years, one attack leaving her without her former knowledge, and the next restoring it. In this case there was shown what is called **double consciousness,** that is, things or persons that may have been seen, or things that may have been heard, during an attack were not remembered when the attack passed off, but were recalled during a succeeding attack. In the same way, anything seen or learned in the interval between two attacks was entirely forgotten in succeeding attacks, but was easily remembered in the intervals.

Thus, during somnambulism mental processes of a high character may go on, but they leave no recollection behind them.

A curious circumstance is that a person walking in sleep will move round obstacles in his path, and guide his course just as if he were fully awake and fully conscious of all his movements. This may be explained by reflex action (see p. 94), the objects making impressions on the eyes, and those impressions through the nervous ganglia at the base of the brain stimulating in a habitual way certain centres for movement. Often, however, somnambulists walk into dangers that cause their death.

The ordinary forms of sleep-talking and sleep-walking are common enough in children.

The **treatment** of such conditions must largely depend on the person, whether child or adult. Anything that over-excites should be avoided, whether over-feeding, or feeding with too rich diet, or over-exercise, or over-study, or the over-excitement of pleasure. At the same time it must be looked to that the person, and especially the child, is not given to very deep slumber because of poverty of blood, and consequent insufficient nourishment of the brain for its healthy activity. Means should be taken if possible to prevent the occurrence of sleep-walking by awaking the person during the night. If the tendency is to walk at a certain time, this will be especially beneficial by anticipating the period, and so gradually weakening the habit. Children of this tendency should never be allowed to sleep alone; and in all cases precautions should be taken to prevent a sleep-walker from opening windows, outer doors, &c.

For children, bromide of potassium, in 5-grain doses, at bed-time, is specially valuable in allaying any excitable condition from which the disorder may spring.

Sleeplessness (Insomnia) is of many kinds, from absolute wakefulness, accompanied by a busy brain, probably the result of it, to the dull stupor that is not true sleep, or the broken fitful snatches disturbed by dreams and fancies, generally of a disagreeable sort. Like headache, it has a variety of causes. Overwork and worry is a common cause. The business or

professional man, especially those who have to sit late busy with books or ideas, if he goes straight off to bed, very likely sleeps little or badly. Similarly, the woman who has many engrossing household cares, and who, with running about and directing affairs, is intensely fatigued, is likely to pass a night that, with sleep, or without it, will probably prove unprofitable in the morning. Badly ventilated apartments can provoke it. Indigestion, constipation, and heavy suppers are well known bad conducers to sleep.

Treatment.—It will be found that quiet rest without work of any sort for an hour at least before retiring is the best preparation the exhausted business man, brain worker, or housewife can have for bed. Every clergyman who has had an evening service knows that if he wishes to sleep he must let some of his excitement work off before going to bed, and he usually aids its departure with a quiet smoke and talk by the fireside. To a mild smoke to the man accustomed to it there is no possible objection. Brisk evening exercise in the open air, the use of the cold bath, or the mustard foot-bath, to draw the blood from the head, may be tried.

None of these methods is of any avail to many people, and meanwhile the sleeplessness becomes painful, exhausting, or killing. Some drug must be resorted to; which should it be? **Not opium, and not chloral hydrate.** The use of both of these grows perniciously. The man who accustoms himself to his nightly dose of opium requires increasingly larger and larger doses, and soon begins to use the drug for relief from other troubles. Chloral hydrate, too, gains a wretched mastery, and has had its countless victims found dead in the morning, because in their confidence in its use an overdose had by mistake been taken. Again the safe drug is bromide of potassium—30-grain doses in a wine-glassful of water. Failing it, extract of Indian hemp is not so hurtful as opium, but must also be watched. A dose of $\frac{1}{2}$ to 1 grain in pill on going to bed may be tried, but *not constantly*. Any nervous condition of which sleeplessness may be only another expression should be treated during the daytime, perhaps with tonics, for example, the phosphorus pill recommended for nervous headache. Wakefulness as the result of indigestion is to be treated by the removal of the cause.

Nightmare is a condition of great activity of certain nervous structures that occasions dreams of a very vivid and usually terrible and distressing character. The anguish of the situation is increased by the want of voluntary power, and the inability to move or cry out. When this is at last, after a seemingly intense struggle, effected, the person awakes. In children nightmare—night-terrors, as it is sometimes called—occurs, in which the child wakes up some hours after going to sleep, in great fright, with a piercing cry and staring eyeballs.

Treatment.—Nightmare is very frequently due to indigestion or errors of diet, and these must at once be seen to and corrected. The adult must avoid heavy suppers, and the child must not be overfed. The bowels should be relieved by ordinary purgative medicine, such as castor-oil. If the child be specially nervous the bromide of potassium, as recommended for somnambulism, may be given.

Other diseases, such as paralysis, epilepsy, &c., are discussed further on, for though they may spring from causes affecting the brain, they may also be due to affections of the spinal cord or other parts of the nervous system.

II. Diseases of the Spinal Cord.

Inflammation. It has been pointed out (p. 97) that the spinal cord consists, like the brain, of white and grey nervous matter, arranged in a particular way, and enveloped in membranes. It too has its supply of blood for its growth and vigour. The cord, consequently, will be liable to inflammations of its own substances, or inflammations attacking its membranes. As similar affections attacking the membranes of the brain are called Cerebral Meningitis, so those of the spine are called **Spinal Meningitis.** Inflammation of the substance of the cord itself is called **Spinal Myelitis.** It is sufficient to mention these names, and quite unnecessary to detail the symptoms. The affections are not so common as to require description in a work of this kind, and besides, the determining of their presence is a work of difficulty for even skilled physicians. The diseases are associated with pains of various kinds and with paralysis.

Inflammation of the cord, however, may be set up by injuries, or by exposure to cold and wet, and manifests itself by fever, intense pain in the back, and paralysis of the lower limbs. In such cases relief may be obtained by the use of leeches and hot applications. The paralysis may remain after the inflammation has passed away, requiring the use of blisters, friction, electricity, &c., conjoined with nerve tonics, to restore the function.

Degeneration of the cord is the general cause of various kinds of paralysis. In one form of degeneration the breaking down of the nerve-cells and wasting of nerve-fibres is associated with an increased formation of other forms of cells and fine connective tissue, so that the part of the cord subject to these changes is deprived of its natural structure and becomes hardened. This condition is called **sclerosis** (Greek, *sklēros*, hard).

Congestion of the cord is usually of a chronic form, occurring in old people. It is attended by rather vague symptoms, among which are aching back and limbs, and diminished muscular power, especially of the lower extremities. Its treatment should be conducted with friction to the spine, and the use of tonic medicines and nourishing food.

Spinal Irritation is a phrase of frequent use, and yet it is difficult to say whether it signifies any special disease.

The **symptoms** which are included under the phrase are various: pain or tenderness in various parts of the body, a feeling of constriction of the chest, a sensation of a lump in the throat, cough, palpitation, and specially constant sickness and vomiting. These occur usually in hysterical girls. On tapping with the knuckle down the back over the spines of the vertebræ a place is reached where there is distinct shrinking by the patient from the stroke. On testing again by passing hot and cold sponges alternately down the spine, shrinking occurs when the sponges pass over the special spot. It is to be observed that the tenderness is invariably *over a spot.*

The **treatment** of spinal irritation consists in the application of blisters over the painful spot. Often one blister has a most marvellous effect, causing the disappearance of the pains and the relief of the sickness. To this should be conjoined the use of nourishing food, and quinine and iron tonics. Change of air is also valuable, the general treatment being directed to the removal of the hysterical condition, which, in most cases, is at the root of the trouble.

Concussion of the spinal cord is the result of shock, such as that due to a fall, a throw from a horse or gig, or shock received in a railway collision, &c.

The **symptoms** are often very vague. For instance, after recovery from the immediate shock of a severe shake in a railway accident, the person may feel comparatively well. After some days, however, even weeks, insidious symptoms may appear, tingling sensations, numbness or coldness of the limbs, loss of power, difficulty in walking, and perhaps ultimately paralysis. Unfortunately, owing to the considerable amount of money frequently obtainable in name of damages for such injuries, there is great temptation for dishonest persons to feign these and similar symptoms, even to the paralysis. It is very difficult for surgeons to express a decided opinion, just because the symptoms are subjective, that is, reveal themselves to the patient only. One test, however, is frequently applicable, that of electricity, which in such cases is capable of revealing with certainty the presence of actual changes in the healthy condition of nerves and muscles.

The **treatment** adopted by a person who has received such a shock ought to be to get to bed as quickly and quietly as possible. Absolute rest may prevent the development of any inflammatory processes. Any further steps should be taken only with medical advice.

Spina Bifida. Refer to DISEASES OF CHILDREN.

III. General Nervous Diseases. Paralysis.

Paralysis comes from a Greek verb meaning to relax or disable at the side. **Paresis** and **palsy** are terms also used to imply the same condition of loss of power. The paralysis may mean loss of power of moving, or loss of power of feeling. In some diseases both occur, and the paralysis is said to be *perfect* or *complete.* In other diseases only one may occur, and the paralysis is said to be *imperfect* or *incomplete,* and then **paralysis of motion** is spoken of, or **paralysis of sensation,** as the case may be. Paralysis of sensation is also called **anæsthesia.**

Paralysis may arise from disease of the brain, disease of the spinal cord, diseases of nerves or of muscles, or may be due to poisons, especially to lead poisoning. According to the seat of the disease is the nature and extent of the paralysis.

Hemiplegia is a paralysis that is limited to one side of the body. In it the power of moving voluntarily the muscles of the affected side is lost. It is due to disease of the brain. Now it has been mentioned (p. 92) that the corpora striata at the base of the brain are to be regarded as the centres for motion, and that when we will to move any part of the body the impulse descends from the cerebral hemisphere to the corpus striatum, and is transmitted by it down the spinal cord and out by nerves to the

muscles that are to be moved. It was also mentioned that the fibres that carry such impulses from the corpus striatum cross over from one side to the other in the medulla oblongata, so that messages from the right corpus striatum pass to the left side of the body, and from the left corpus striatum to the right side of the body. Thus any disease on the *right side of the brain,* which prevents the message from the will reaching the corpus striatum, or any disease which injures the corpus, or which prevents the message transmitted from it reaching the spinal cord, will produce paralysis—hemiplegia—of the *left side of the body*, while any disease in similar positions on the *left side of the brain* will produce paralysis of the *right side of the body.* The disease is generally due to the bursting of a blood-vessel, the blood from which forces its way among the delicate nervous structure, destroying it; or it may be due to a blood-vessel being blocked, for instance by a small clot of blood sent from the heart, a condition frequently caused by rheumatic fever, and called **embolism.** When a clot is the cause of the paralysis the area of brain substance supplied by the blocked vessel is suddenly deprived of its accustomed quantity of blood, and is thus rendered incapable of performing its duties.

Symptoms.—The paralysis may come on suddenly without consciousness being lost, the person suddenly discovering that he has lost the power of one side. It may come on with giddiness and confusion of thought, or with a severe pain in the head, or with sickness, pallor, and faintness, or with entire loss of consciousness. In some cases the paralysis is at first slight, but progresses, and passes on to unconsciousness, which may be recovered from, the paralysis of one side remaining; or it may deepen into death. In an ordinary case the one side of the body will be found powerless, though feeling remains, the same side of the face is paralysed, and the active muscles of the opposite side consequently pull the face to that side, so that the face is twisted. There is thickness and indistinctness of speech, and when the person puts out his tongue it is pointed towards the paralysed side, because one half of it is paralysed. In less severe cases some power may be left in the leg, though the arm may be quite useless. The mind may be affected, but is frequently apparently not so. In favourable cases recovery begins in the leg. Recovery may be complete, or only up to a certain point, or not at all. Instead of recovering the paralysed limbs may become rigid, the mind enfeebled, and the body fail, so that bed-sores form. Other attacks are apt to follow the first.

Treatment consists in removing the patient at once to bed in a quiet well-ventilated room, the head being slightly raised. If he is unconscious, practically nothing can be done except to keep him undisturbed till consciousness returns. Then he is to be fed on a simple, nourishing diet, milk especially, all stimulants being forbidden. His bowels must be regulated, but not with strong medicines: an injection of warm soapy water is very useful. Nothing further should be attempted without medical advice.

Cross Paralysis is the name given to the paralysis of one side of the body and the opposite side of the face. It indicates the disease to be in the region of the medulla oblongata, and is more serious than ordinary hemiplegia, because, as explained (p. 93), in this region are many centres whose activity is necessary to life. For instance, in this neighbourhood are the centres for breathing and for swallowing. If, therefore, swallowing is difficult or impossible, it indicates the great gravity of the case.

Paraplegia is the term applied to paralysis proceeding from disease of the spinal cord. The extent of the paralysis naturally depends on the level in the spinal cord where the disease exists. If it be low down the functions of the bowels and bladder are interfered with, and the legs are paralysed; if it be much higher up, the muscles of the trunk are also involved, and the upper limbs. Usually it is the lower half of the body that is affected. Both motion and sensation may be paralysed, or owing to a peculiar distribution of the disease in the cord motion may be paralysed on one side and sensation on the other.

The **symptoms**, thus, generally include paralysis of the lower limbs, and involuntary discharges from the bowel and bladder. While the person cannot move his legs by the power of his own will, they may move involuntarily and start spasmodically because of reflex action (see p. 87).

The **treatment** depends on the cause of the disease, which may be inflammatory action in part of the cord, effusion of blood into the cord, disease of the vertebræ, want of due supply of blood to the cord, syphilis, and other causes. This it is often difficult to determine.

Till competent advice can be obtained the patient is simply to be kept clean and dry, and to be given simple, nourishing diet. Deep sores are

apt to form, and to guard against this watchfulness is necessary. (See p. 47.)

Aphasia (Greek *a*, not, and *phasis*, speech) is the term first used by the French physician Trousseau to denote loss of the power of speech due to disease of the brain, and not to paralysis of the organs of speech. It has various forms difficult of distinguishing. One form has been called **aphemia** (*a*, not, and *phēmi*, I speak), in which the person has lost the power of willing the combined movements which go to produce speech. At the same time he can read to himself, write, and understand what is said to him, but cannot himself produce the movements that will enable him to express himself. In another form, called **amnesia** (*a*, not, and *mnēmē*, memory), the person loses memory of words, so that he cannot speak, nor read to himself, nor write. He may retain a few words, which he employs indiscriminately. He can repeat words dictated to him, and seems to understand what is said. In **agraphia** (*a*, not, and *grapho*, I write) there is loss of power to write, not from paralysis of the hand or fingers, but from inability to express ideas in writing. At the same time the person may be able to read and speak, but when he or she tries to write, jargon is the only result, though the letters can be formed quite distinctly and properly. These affections, all grouped under the name aphasia, were attributed by the late M. Broca of Paris to disease situated in a special region on the left side of the brain in front. The disease is sometimes transitory, being due to slight congestion of part of the brain, occurring after long illnesses, more especially fevers. Much more frequently, however, it is partially or entirely permanent, caused by apoplexy, softening of the brain, or the pressure of a tumour. Sometimes aphasia occurs alone; at other times it is accompanied by paralysis of one side of the body, generally the right side.

The **treatment** demands the aid of a physician, and consists in attention to the bowels, the use of good easily digested food, avoidance of all excitements, and the employment of tonics, such as iron, quinine, and strychnine.

Local Paralysis is the phrase used to signify that one muscle or a group of muscles is affected. It does not spring from disease of the brain or spinal cord, but from some disease of, or injury to, a particular nerve-trunk. An accident, for instance, to an arm may have so bruised or otherwise injured one of the nerves that it is cut off from its centre in the cord, and consequently wastes. The muscles to which this nerve proceeded are consequently deprived of its influence, and are therefore paralysed. In fracture such an injury might be caused by the ragged ends of the broken bone. A tumour pressing on the nerve might produce the same results. If a sensory nerve is involved then the region of skin supplied by that nerve is devoid of sensibility. The trouble of such local paralysis is that the muscles, deprived of their nerve supply, speedily waste, lose their power of responding to a stimulus, and become weak and soft. Facial palsy is an example of this kind of paralysis.

Facial Palsy, paralysis of one side of the face, is due to some affection of the part of the seventh cranial nerve (p. 96) which confers movement on the muscles of the face. This affection of the nerve may occur in any part of its course from the brain to the muscles of the face. The common form, and the form which it is desirable to note in this place, is frequently due to cold caught by a person sitting in a railway train at the side of an open window and facing the engine, so that the draught blows on one side of the face. It has been mentioned that one half of the face is paralysed in hemiplegia, but this paralysis of the face differs from what is called facial palsy in the completeness of the paralysis in the latter case as shown by the symptoms.

Symptoms.—One side of the face is motionless, quite smooth, unwrinkled, and soft. The patient cannot shut the eye of one side, the eyeball is consequently exposed continually, dust may lodge on it, and thus a state of constant irritation is set up, and the tears flow over the cheek. The person cannot whistle or blow out a light. When he tries, the paralysed cheek is simply blown up with the air. When he eats, food is apt to lodge between the gums of the affected side and the cheek, and is productive of great annoyance. Sometimes the hearing and taste are affected. The brow is smooth on the palsied side, and when the patient wrinkles his brows only the healthy side is thrown into furrows. The face is drawn to the healthy side by the action of the muscles of that side. When the person tries to laugh or make a grimace the result is very ridiculous, one side responding and the other being absolutely smooth. Now in paralysis of the face, due to hemiplegia, the eye and forehead usually escape.

Besides cold, rheumatism, inflammation of the ear, and decayed teeth, may cause this affection.

Treatment.—Let the patient be sure that rheumatism, ear or tooth affection, is not present to account for the paralysis. If it is believed to be due to cold, the probability of recovery is great, but not for a few weeks or perhaps some months. If it is due to cold, the speedy application of leeches on the bone immediately behind the ear, and, after it, blisters, hot fomentations, &c., are recommended. Later the most beneficial treatment is with electricity, which, even after the lapse of considerable time, will restore the nourishment and tone of the muscles, and has great chance with patient use, of ultimately restoring voluntary movement. Let it be observed that electricity does not mean magnetism, and that the use of magnetic belts, collars, &c., are absolutely valueless. The electricity to be used is either that obtained directly from a galvanic battery, or the kind called induced electricity, obtained by sending a galvanic current round a specially constructed coil of wire (induction-coil), and the electricity should be directly applied to the paralysed muscles.

There are several varieties of paralysis due to degenerations going on in various portions of the spinal cord. Some of these will be briefly described, others will only be mentioned.

Locomotor Ataxy (Greek *a*, not, and *tasso*, to order) is a peculiar disease, so called because sufferers from it cannot order their movements for definite purposes, so that walking is difficult, and there is a peculiarly awkward gait.

The **symptoms** are specially connected with movement. The person needs to guide the movements of his feet and legs by means of his sight, so that if his eyes are shut, or if he is in the dark, he loses balance, and cannot go at all. When he walks, his feet are lifted up extravagantly high and jerked out and brought down in a violent way. This difficulty of movement is called "want of co-ordination of movement." In advanced stages it becomes so extreme that the person cannot take even a couple of steps, and is confined to his bed or chair; and this although there is plenty of muscular power in his limbs, and although he can move them easily enough when lying in his bed. Associated with the difficulty of movement is a peculiar tingling and numbness and loss of sensibility in his toes and feet, so that he feels as if he were walking on some thick soft material. These are the most striking symptoms when the disease is developed. For some time previous to this, however, perhaps even for years previously, there may be what are called premonitory symptoms. The chief of these are shooting and boring pains affecting the trunk and lower limbs. There are also feelings of constriction and pains connected with the abdominal organs, especially intense pains in the stomach. There are also affections of various other parts of the body, joints, ear, and eye. There may be squinting, double vision, defective sight. In particular the pupils of the eye are very small. The disease extends to the hand and arm, and their movements are affected, the clumsiness of movement being remarkable.

The **causes** of the disease are not well known. Sexual excess, exposure to cold, over-exertion, syphilis, are all said to be causes. Its progress is very slow, extending often over many years, and recovery is rare. It is not common in women.

The **treatment** consists mainly in measures for maintaining the general health. Nothing is as yet known to have any permanent benefit.

Shaking Palsy (Tremor—Paralysis Agitans) is characterized by tremulousness of muscles quite apart from any effort at movements. When developed, the trembling is incessant, affecting several limbs. It does not stop during sleep, and may be sufficient to prevent sleep. In walking, the patient usually bends head and trunk in advance, and then runs straight forward, as a man trying to regain his balance. The muscles tend to become rigid and cramped, and great restlessness is exhibited.

Treatment is as hopeless as that for the preceding paralysis.

Wasting Palsy (Progressive Muscular Atrophy—Creeping Palsy) is attended with loss of muscular power, and, associated with the loss of power, wasting of the muscle. It generally begins slowly, attacking one muscle, or a group of them, the muscles of the ball of the right thumb being usually first affected, then the muscles opposite—those of the little finger. The wasting gives the hand a claw-like look. Then the disease passes up the limb, from forearm to upper arm and shoulder, then on to the trunk, afterwards invading the lower limbs. The course of the disease is slow, unless the muscles connected with breathing and swallowing become affected early, when choking or difficulty of breathing is liable, with attendant troubles, to cut off the patient in two or three years.

Among its causes, exposure to cold and wet are mentioned as chief. It attacks children, however, sometimes, and appears in them to be hereditary.

The chief **treatment** is with electricity, which

seems to do good by so acting on the muscles as to restore their nutrition and arrest wasting.

Pseudo-hypertrophic Paralysis is a paralysis occurring in children, and especially boys, and attended with apparent increased growth of muscles, particularly of the calves and buttocks. The increased growth is only apparent, however, the muscular fibres actually dwindling, while the increased size is due to fat and connective tissue between them. Feebleness of the muscles of the legs appears to be among the early symptoms, and the boy walks with legs kept apart and shoulders thrown back. The affection of the muscles, which begins low, passes upwards, affecting muscles of back and trunk, arms and face. As the bulk of the muscles increases, the waddling movement of the child is more pronounced, he has grea difficulty in getting up, and is constantly falling. With the enlargement, the weakness of the muscles keeps pace, till the child becomes helpless. Death usually occurs before eighteen.

No **treatment** is of any avail if the disease has reached the stage of muscular enlargement. Before that period electricity seems the main remedy.

Infantile Paralysis occurs in children during the second year of life, but may be any time between birth and ten years of age. Like the other forms, exposure to cold is said to be a frequent cause, teething being also set down as favouring its occurrence.

The **symptoms** begin with fever, accompanied now and again with convulsions. The paralysis occurs quickly, and increases rapidly, sometimes arms and legs being attacked, sometimes only groups of muscles in them. The muscles rapidly lose their power, become relaxed and cold. After some time—two to six months —some improvement may take place. Later, however, owing to the irregular wasting of the muscles, or the unequal recovery, deformities result, mainly of the hand and foot. Frequently also the bones of the affected parts cease to grow.

The **treatment**, while the attack of fever lasts, is simple, attention to procure movement of the bowels, and the giving of light diet. The use of electricity is highly commended in the later stage, to prevent the rapid wasting of muscles, and to restore those already wasted.

Lead Palsy, in which the paralysis is usually limited to the extensor muscles of the forearm, specially the right, is one of the commonest symptoms of *chronic lead poisoning*. The lead poisoning may arise from many circumstances—workers in white-lead manufactories, painters, plumbers, those engaged in glazing pottery where oxide of lead is used, makers of some kinds of glazed cards, bleachers of Brussels lace, are all liable to it. It is those who work among preparations of lead, however, and not those who work with the metal itself, that are most liable. Lead may be taken into the system also in drinking water which has lain in leaden cisterns or leaden pipes. Hard waters which contain sulphate and carbonate of lime act less readily on lead than soft waters. Lead poisoning has been due to drinking wines contaminated with the metal, and to the drinking of Devonshire cider made in leaden vessels. The use of cosmetics containing lead has also been productive of harm.

The **symptoms** of lead poisoning, besides paralysis, are general ill-health, sallow complexion, metallic taste in the mouth, the formation of a blue line along the edges of the gums next the teeth, and colic and vomiting. The paralysis affects particular muscles, so that the person cannot extend the back of the hand, *the wrist consequently drops*, and cannot be raised. The affected muscles waste, and a hollow appears on the back of the forearm. Other muscles—those of the shoulder and back of the arm—occasionally suffer.

Treatment consists first of all in removing the person from the source of the poison, which should be carefully investigated. Those who engage in lead works, or in works where lead is largely used, should cultivate strict cleanliness, and should use the tooth-brush to get rid of any of the dust that may adhere to the teeth and gums. For the colic and vomiting, 10 grains of calomel and 1 to 2 grains of opium are given, followed by a dose of castor-oil, and warm fomentations are applied over the abdomen. Iodide of potassium given internally in small quantities (1 to 3 grain doses) is believed to remove the lead from the system. For the paralysis, electricity is the only remedy of value.

Convulsive Diseases.

Convulsions may be simply an incident of a disease, as in epilepsy and hysteria, or they may be the disease in themselves. As an independent affection they affect both grown-up people and children, but the latter are specially liable to them because of reasons that will be explained in dealing with convulsions occurring in children. (See DISEASES OF CHILDREN.) They occur in women associated with pregnancy or

childbirth. (See DISEASES OF WOMEN.) They consist in violent contractions of the muscles of the body, and are beyond the control of the will. Sometimes the spasm remains for some time, and the affected muscles are felt to be rigid; at other times the spasm quickly relaxes and then recurs, so that jerking movements are produced. The former is called **tonic** spasm, the latter **clonic** spasm.

The **causes** of convulsions in adults (those of children will not be dealt with here) are various. Affections of the brain, such as inflammation, tumour, and injury, will produce them. Great loss of blood, producing sudden great deficiency of blood in the brain, causes them. Besides these, poisons may give rise to them, whether the poisons have been introduced into the blood from without, such as strychnine, the poison of syphilis and hydrophobia, or whether they have accumulated in the blood from disease of organs, as, for example, from disease of the kidney, preventing that organ from separating certain waste substances from the blood.

The **symptoms** are chiefly the sudden spasmodic movements of the muscles, either all the muscles of the body or groups of them only—the muscles of one side, of one leg or arm, of the face. The spasms may be slight or severe, and unconsciousness, more or less complete, attends them. Distortion of the face, staring eyeballs, or eyeballs drawn to one side, grinding of the teeth, wideness of pupils of the eyes, which are not affected by light, are some of the symptoms that may occur. The gravity of the case is dependent on the cause.

The **treatment** also depends on the cause, which it is often difficult even for a physician to ascertain. All that others can do is to place the person in bed, and loosen the clothing. To save the biting of the tongue, a piece of cork should be placed between the teeth, or the handle of a horn spoon. Nor yet can a mistake be made by securing a speedy movement of the bowels, obtained readily by an injection of salt and water. (See ENEMA.) Cold may be applied to the head or dashed over the head and chest, and warmth to the feet and over the stomach. This is all that can be done till the cause of the convulsions is ascertained, which will determine the further treatment.

Epilepsy (falling-sickness, Greek *epilepsia*, a seizure) is a disease of which, in its fully developed form, convulsions, attended by complete unconsciousness, are the prominent feature.

The **causes** of the disease are not accurately known. It is certain, however, that the tendency to epilepsy runs in families, along with other nervous diseases, such as insanity, hysteria, and St. Vitus' dance. Cases have been attributed to excesses in drink and in other directions, and in children to fright. Whether fright can actually produce it may be questioned, but at least the disease may by fright be suddenly started in children who were liable to it, and who, but for the sudden shock, might have passed the danger.

The **symptoms** of a typical case are that the person becomes deadly pale, suddenly utters a horrible cry, and falls to the ground. He may be seen to be drawn to one side, his face distorted, his eyes turned up, revealing the white, and his tongue, perhaps, caught and severely bitten by the teeth. The spasm passes over his whole body, so that in a few seconds he is quite rigid, and his breathing is stopped. From the first he is quite insensible. In a very short time his face becomes swollen and congested; jerky spasmodic movements of muscles commence, the limbs being jerked, the head and mouth twitching, and the eyes rolling, the tongue probably being caught by the movements of the jaw; the breathing returns, but is noisy and difficult; froth and blood from the injured tongue escape from the mouth; and the urine may be discharged. Profuse sweating occurs, and in a little longer time, at most two or three minutes, the spasmodic movements slowly cease, the person sighs deeply, and shows signs of returning consciousness. Sensibility may return at once or slowly, and the person be dull and exhausted for some time afterwards, or a deep sleep may succeed the fit. The attack is often preceded by a warning, which may take very curious forms. In one form it is a tingling which creeps up from an extremity towards the head — the **epileptic aura**, it is called; in another case it is some pain, sense of coldness or heat starting upwards from a point of the body. To some persons the warning is in the shape of a hallucination. One patient, previous to a fit, always saw a little old woman in a red cloak. The warning may be sufficient to enable the person to get out of some dangerous position, to get down from horseback, to get off the street, &c. One man, whom the writer met, who was very subject to the attack, after a warning in the street, started to run, and ran till he could not go a step further, and so succeeded in preventing the attack. Rarely the warning is a considerable time before the attack, showing

itself by depression or some change of feeling, or by excitement in the person.

Now while these are the ordinary features of a regular fit of epilepsy, there are many attacks that can be set down as nothing else than modified fits which have yet little resemblance to the fully-developed form of the disease. One of the most notable examples of these unusual forms is where the person may become suddenly unconscious, arrest for the moment whatever work he may be engaged in, and after a few seconds resume the business he was engaged in, without being aware of any interruption. Thus a professor lecturing to his class has suddenly stopped in the middle of a sentence, his eyes looking fixedly in one direction, his hands retained in the attitude in which they happened to be at the moment, and after a few seconds has resumed the thread of his discourse, where it was left off, without any knowledge of the stoppage. French writers distinguish between the severe and mild form, by calling the former *grand mal*, and the latter *petit mal*. But the business or action with which the person is occupied need not be arrested. Thus a violinist has been known to be seized while playing, but to go on with perfect accuracy. Again, a man, working at his bench, has been known to drop his tools, on being attacked, put on his hat, and walk a considerable distance, all the time unconscious, and has wakened up to find himself seated in a public-house, quite at a loss to understand how he got there. So in other unusual forms of the disease, the person may commit not only strange but wild acts, commit an unprovoked assault in the street, be roused out of his sleep by the seizure to brutally beat his wife or dash out the brains of his child. In all these remarkable forms the features are the entire unconsciousness of the person during the attack, however guided by purpose may seem his actions, and the complete ignorance of what has occurred after the attack has passed off. The latter forms are not common, but probably the first irregular form described—that of simple momentary unconsciousness and arrest of movement—is much more common than is supposed.

Epileptic fits are commoner during night than day, especially the mild form. Thus a person may regularly suffer from epileptic attacks, which come on in bed, of which neither he nor anyone has any knowledge, and whose only indication is a feeling of fatigue and soreness felt in the morning. If the fits be of the severer form, then a swollen sore state of the tongue, and blood upon the pillow, perhaps also urine discharged into the bed, are the evidences. Death, owing to suffocation, sometimes results from epileptic attacks occurring during the night. Epileptic attacks may recur often or seldom. Sometimes a person will suffer from daily fits for some time, and then be free for months or longer, and again have a period of recurrence. They may occur not only daily, but several times throughout the day or night. In spite of their frequent recurrence, they do not immediately tend to shorten life, but they affect the patient's health and mental condition.

Treatment is often a matter of considerable difficulty, some cases stubbornly resisting all methods. The treatment during the fit is simple. Lay the patient flat on the floor, insert a pad of some sort between his teeth to prevent injury to the tongue, and otherwise let anything be done to prevent the person injuring himself. The clothing about the neck and waist should be loosened. Apart from this nothing avails anything, and one must simply wait till consciousness returns. A person liable to fits should never be in circumstances when the occurrence of the seizure might endanger his life. He should not, for instance, ride on horseback or a bicycle, or drive in a gig, nor be sitting beside a fire in such a way that he might fall into it, nor walk along dangerous pathways, or go out boating or fishing alone.

Much may be done to diminish the liability to the attacks by general treatment. Good easily-digested food, fresh air, moderate exercise, abstinence from exciting foods, drinks, exercises, *or amusements*, especially abstinence from sexual excesses and degrading habits connected with them, should be the rule. Moderation in all things will aid much his general bodily and mental strength.

Whatever be the ultimate cause of epilepsy, and the ultimate cause is yet doubtful, it is certain that a fit may be determined in a likely person by some irritation, for instance in a child by irritation in the bowels due to worms, and in a woman by irritation connected with the womb. Such irritating causes must, therefore, be removed by appropriate treatment. This, however, only treats the tendency to the disease. For the disease itself a vast number of drugs have been tried—opium, arsenic, zinc, digitalis, &c. Undoubtedly the two most useful are bromide of potassium and belladonna, the latter urgently recommended by M. Trousseau, the distinguished physician of Paris. The former is given in doses from 5 (for children) to 30 (for adults) grains in water thrice daily, and it

will be found useful to give it with half to one teaspoonful of aromatic spirit of ammonia (sal volatile); the latter is given in pills containing (for an adult) $\frac{1}{8}$th grain of belladonna extract, and the same quantity of the powdered leaves, one at night or in the morning according to the usual time of the fit. One pill is to be given daily for the first month, then two for the second month, three for the third, and so on till five and even more are taken daily. Both remedies should be continued for a long time. If the use of these drugs has held the disease in check, then after some months probably a pill containing $\frac{1}{50}$th grain of phosphorus would be of value in the way of restoring nerve tone. It is necessary to state that a distinguished German professor, Schroeder Van der Kolk, believed the disease to be seated in the medulla oblongata, and to be due to chronic irritation and congestion. The treatment he urged as of most advantage in old cases was cupping the neck and the use on the neck of issues, and specially setons, continued for a long time. These remedies he believed acted by withdrawing blood from the medulla, and diminishing congestion.

St. Vitus' Dance (Chorea) is a disease attended by irregular spasmodic movements of voluntary muscles. It occurs chiefly among children from the beginning of the second teething to the age of fifteen, and is more frequent among girls than among boys. It may occur, though it is uncommon, in adults. A curious relation exists between chorea, acute rheumatism, and heart-disease. Rheumatism is well known as a most common cause of heart-disease, and heart-disease is frequently associated with St. Vitus' Dance. Moreover, rheumatism seems to be able to descend from parents to children, and it has been found that the children of rheumatic parents, instead of rheumatism, may manifest chorea or heart-disease, or both combined. Fright is a frequently alleged cause.

The **symptoms** in the fully-developed case are remarkable. The patient has no proper control of muscular movements. He cannot keep himself still. The shoulder is hitched, the arm moved about, the fingers twitching. All sorts of grimaces and contortions are produced by spasmodic movements of the muscles of the face. The movements cease during sleep. When the person attempts to do something, to grasp some object held out, or to carry anything to the mouth, the jerks become excessively marked. One failure follows another. The hand is nearing the object when it is suddenly twitched away in one direction and then in another, and the case may be so bad that he is unable, after numerous attempts, to effect the desired purpose. Efforts, specially if any one is watching, seem only to increase the difficulty. Similarly spasmodic movements of the leg produce in walking a jerky, uncertain, jumping gait. Speaking is altered, becoming hesitating or drawling. In extreme cases chewing and swallowing are also seriously affected, and swallowing may become impossible. The case under these circumstances is easily recognized. But the disease comes on slowly, and may at first manifest itself only by slight twitchings of the muscles of expression. Children may be supposed to be grimacing on purpose, and may be reproved and even punished at school or at home while they are innocent of wrong. The writer saw a case brought to an institution for diseases of the eye because of a constant winking movement of the eyelids. On watching the boy carefully for a few minutes he saw slight tremor of other muscles of the face, and it became evident that the disease was not one of the eyelids, but this nervous affection. The child usually suffers in general health, becomes dull, and avoids companions, probably often because of the derision with which he is ignorantly treated. He may suffer mentally as well, become fretful and timid. Indeed fretfulness, timidity, restlessness, and clumsiness of gait and movement, may be the ways in which the disease first shows itself.

The affection may be only one-sided; but, if it be general, one side is usually worse than the other.

Recovery may take place speedily in the course of a few weeks, or it may be prolonged for two or three months or even for years. The extreme cases where swallowing becomes affected are very serious, and, as well as those where the heart is affected, likely to prove fatal.

The **treatment** consists first of all of attention to the general health. Let the bowels be put in order; let the food be light and nourishing. Fresh air, early hours, gentle exercise, mild gymnastics if possible, tepid sponging, especially with salt-water, sea air also, if possible, are invaluable. The child should not be subjected to the annoyance of rude companions. At the same time it must not be petted and spoiled at home, but treated just with the same consideration that is owing every child. Notice must not be taken of its peculiarity. Of medicines, tonics are best, the chief being iron and

arsenic; but these should be used under the guidance of a medical man, especially arsenic, whose administration, because of certain peculiarities in its action, requires great care. If such guidance cannot be obtained, the two drugs may be given together, one drop of Fowler's solution of arsenic, and three drops dialysed iron in water *after meals* four times a day. This may be slowly increased to two drops of the arsenical solution and five of the iron. If sickness, pain in the stomach, irritation of the eyelids, and silvery-looking tongue are produced, these indicate that the dose must be reduced. When the dose is reduced it must be done slowly, and *never suddenly stopped.* For arsenic should always be administered in small doses, slowly increased, and when it is desired to stop its use the dose must be as slowly decreased till it can be gradually abandoned. *A caution is necessary.* Chorea sometimes spreads *by imitation.* Children in a family may exhibit the spasmodic movements from watching those of one member of the family affected with the disease.

Tetanus (lock-jaw) is a disease of a spasmodic character in which, however, the spasms do not yield and then recur as in convulsions, forming what has been described as the **clonic** spasm (p. 123), but in which the spasms continue, causing stiffness and rigidity of the affected muscles, forming the **tonic** spasm.

Its **causes** are usually injury, sometimes simple bruises or cuts, but more frequently injuries accompanied with great destruction or crushing of parts of the body. It is, moreover, injuries obtained under circumstances that prevent their proper treatment that are most liable to occasion the disease. Tetanus is thus found among the wounded in war, who have been exposed to cold and wet. It may arise without injury, owing to exposure to cold. It is more common in hot than cold climates.

Symptoms begin with stiffness and pain in muscles of the jaw and throat, giving the patient the idea that he has caught cold. With the advance of the disease, swallowing becomes difficult, even opening the mouth becomes not easy, and at length the mouth is kept firmly closed, and the jaw fixed, hence the name lock-jaw. Spasms of the muscles of the mouth draw down the corners of the mouth, showing the teeth and giving the person a grinning appearance—sardonic grin. The extension of the spasm involves the muscles of the back, belly, and limbs, so that the patient lies on his back quite rigid. The chief muscle connected with breathing—the diaphragm—may be attacked, so that the breathing is difficult and shallow. A cramp-like pain accompanies the spasm, becoming every now and again agonizing. While the stiffness of the muscles is more or less constant, it is liable to great aggravation at more or less regular intervals. During the aggravations the rigidity of the muscles may become so intense that the person is arched backwards by the excessive contraction of the muscles of the back, a condition called **opisthotonus** (Greek *opisthe*, backwards, and *teino*, I bend)—or bent forwards by the muscles of the belly—**emprosthotonus** (*emprosthen*, forwards). Movement, light, sound, noise, irritation of any sort will bring on the aggravation. The laying of the warm hand on the patient's forehead may be seen to increase the spasm of the muscles of face and neck, by the increased retraction of the corners of the mouth. The paroxysms occur every fifteen or ten minutes, and last a few seconds or even minutes. During them profuse sweating breaks out. The pulse is weak and fast, the temperature is higher than usual, and often indicates the near approach of death by rapidly rising. Thirst is great. Consciousness is usually perfect, even till the end, which usually occurs between the third and fifth day from suffocation during a paroxysm, or from exhaustion. The symptoms are very like those of poisoning from nux vomica or its active principle strychnine, but in the latter case they develop more quickly, and run a more rapid course to death.

Treatment is usually in vain. Much may be done to *diminish the suffering*, little to arrest the disease. Since the smallest thing can provoke a paroxysm, the utmost quiet is necessary. The patient should lie in a darkened room, into which no noise can penetrate. All jarring of doors, stumbling against chairs, &c., should be rigorously avoided. Fussing over the patient can but add to his suffering. A quiet attendant, and only one, should wait upon him, and no visitors ought to be permitted. Early in the progress of the disease a strong dose of calomel and jalap, to produce free movement of the bowels, should be given, so that the patient need not be troubled with this afterwards. Various medicines for relieving the spasm have been tried, belladonna, nicotine (the active principle of tobacco), Indian hemp, calabar bean, woorari (the Indian arrow poison), and others, but all to little purpose. The administration of chloroform kept up for hours and even days is of great use. Such treatment, however, requires medical aid.

Tetany is the name given to the affection in which painful contractions of the muscles of the forearm and wrist, and sometimes of the foot, occur. It does not affect the jaw and back. It is commonest in young people and in children, associated sometimes with rickets, and in women with pregnancy and nursing.

Symptoms.—The thumb and fingers are chiefly affected, the thumb being folded across the palm, and the fingers drawn into a cone, and the hands are usually bent. The attacks of spasm come and go, lasting some minutes or even half an hour, and separated by intervals of a day or two, or sometimes weeks. In children they frequently persist, and last for weeks, continuing during sleep. In children, crowing (child-crowing) is often associated with the disease.

The **treatment** is simple, consisting first in setting right anything that may be wrong with the child's or woman's general health. Tonic treatment will often be required. Bromide of potassium is best suited to relieve the spasm, in 5-grain doses thrice daily to children.

Hysteria, Catalepsy, and Trance

are affections specially of women, and rarely occurring in men, and are, therefore, discussed in the part devoted to DISEASES OF WOMEN.

Neuralgia, Tic Doloureux, Lumbago, Sciatica.

Neuralgia is nerve pain; and it may affect any nerve, occurring sometimes in the trunk of the nerve, but often being felt in the parts in which the affected nerve ends, even though the cause may be acting on the nerve at its origin. It is liable to produce spots painful to touch over the place where a nerve issues from an opening in a bone, or pierces some tissue, to reach the surface.

The **causes** are numerous,—injury to the nerves, or irritation due to some inflammatory action. For example, neuralgia is often due to the irritation set up by a diseased tooth. General bad health is a fruitful source of neuralgia. Depressed health, poverty of blood, or altered conditions of the blood, such as are found in rheumatism and gout, and occasioned by malaria, ought at the very first to be considered in the search for the cause.

Symptoms.—The pain varies in character, being stabbing, tearing, grinding, gnawing, burning, cutting, or tingling, and so on; and it is often, indeed usually, in paroxysms or darts, even when continuous being subject to sudden aggravations of an unbearable sort. During these aggravations the person may be completely unmanned. He presses over the painful place with his hands, his face may flush up, and a profuse perspiration break out, and sudden twitchings of muscles may accompany the spasm of pain.

Frequently the pain recurs at certain periods of the day. It is in such cases quinine is likely to have its best effect.

The **treatment** of neuralgia consists first of all in removing, if possible, the cause, the source of irritation, in rectifying the condition of health which lays the person open to it. Treat rheumatism, gout, bloodlessness, &c., if any of these exist, in the appropriate way. Nourishing food, salt-water bathing, followed by brisk friction of the skin, exercise, early hours, avoidance of fatigue, overwork, and anxiety, regulation of the bowels, and abstinence from stimulants and bad habits, in fact, all means that restore a good tone to the bodily system, will aid in overcoming neuralgic affections. Secondly, medicines may be given directly for the disease; chief of these is quinine, in at least 5-grain doses, and quinine combined with iron, arsenic also *for adults* (5 drops to 8 of Fowler's liquor), or phosphorus in the form of the pill recommended for headache. *A combination of the utmost value, specially in neuralgic headache, is* 5 *grains of quinine, with* 20 *grains of salicylate of soda, given once in the twenty-four hours.* Other treatment will be mentioned in discussing forms of neuralgia.

Tic Doloureux is neuralgia of the fifth nerve (see p. 95). It occurs on one side of the face, produced, it may be, by a diseased tooth, by inflammation in the ear passage, by exposure to cold, by dyspepsia, or other causes. It may affect the whole side of the face, or only parts of the face. When it affects only a certain region of the face, it is usually one of three parts. The fifth nerve has three divisions: one, after passing through the orbit, comes out to the surface, under the skin, near the inner end of the eyebrow, and spreads over the forehead. When this branch is affected the pain spreads from the spot over the forehead. The second branch comes to the surface just below the lower eyelid, and the pain from it spreads over the cheek and upper lip, the side of the nose, and round the under side of the eye. Neuralgia of these branches is readily accompanied by swelling of the face about the eyes, redness of the eyelids, and watering of the eyes. The third

branch runs in the substance of the lower jaw, supplying the teeth, and comes out of the bone by an opening in the middle line in front. Consequently, when the pain is occasioned by it, it is felt along the lower jaw of the one side, in the teeth and chin, and a tender point may be in front over the place of exit of the nerve. The slightest pressure of the jaw, as in chewing, will, in some cases, produce excruciating pain. Thus this branch may be irritated by a decayed tooth, and if the irritation be severe the whole branch may be involved, and the irritation may even spread backwards from it to the other branches, till the whole nerve is affected.

Treatment for tic naturally consists in removing the bad tooth, the disease of the ear, &c., if such exists. Besides the treatment mentioned for neuralgia generally, the application of aconite ointment to a small part of the surface, the use of warm applications and of blisters, and the employment of a constant current of electricity over the affected nerve are all useful. Very often, if a medical man be at hand to administer it, the injection under the skin of $\frac{1}{8}$th of a grain of morphia will relieve in a few minutes.

A sort of **Lumbago** may be produced by neuralgic pain in the small of the back, of a gnawing character, aggravated by much standing or walking. Friction to the spine and the use of phosphorus will aid its removal.

Sciatica is neuralgia of the sciatic nerve, which passes down the back of the thigh to knee (p. 99.) It is often very acute and persistent, resisting all remedies. It may be caused by the pressure of accumulations in the bowels, or tumours within the abdomen.

Its **treatment** is that described for neuralgia, injections of $\frac{1}{8}$th of a grain of morphia under the skin being for it often a necessity.

IV. Injuries and Tumours.

Injuries to the brain are often produced by fracture of the skull. The forms of injury known as compression and concussion have already been noticed (p. 104). The brain may be wounded through the eye by some sharp-pointed instrument being driven through the walls of the orbits into the brain behind. There are many cases on record where a severe blow or fall has smashed to pieces a portion of the skull, and has opened into the brain, and where a considerable quantity of brain substance has been destroyed without any apparent effect on the patient. If a large portion of the skull has been removed in consequence of injury or disease, it is not uncommon for a part of the brain to protrude as a swelling through the opening. Variations may often be noticed in the swelling according with the movements of the heart and breathing. It is impossible to discuss here any treatment for brain injuries beyond what has been already considered at p. 104.

Injuries of nerves are common. A wound may completely divide a nerve; a dislocated bone may so compress it as practically to destroy a portion of it; and a fractured bone may seriously tear it. If a nerve has been severed, or so injured that it is destroyed as a continuous structure, then it is evident that paralysis of sensation or motion will be produced in the part which it supplied, according as it was a motor or sensory nerve. If, however, the cut ends are brought together, they will unite, and in time sensation and motion may return. The earliest such a result could be expected is from three to four weeks. On the other hand, the nerve may be so injured that it is impossible for restoration to be accomplished. In such a case the power of movement will be lost in the muscles to which it proceeded. Further, the muscles will waste and decay, and may contract spasmodically, and so produce deformity. If the nerve has been one of sensation, then degenerative changes will be set up in the region of skin which it supplied, and the skin become blistered, or ulcerated, or covered with eruptions, while numbness will pervade the region. Severe pain and inflammation may also be produced.

The **treatment** of such injuries is so dependent on their character that medical aid can hardly be dispensed with. It need only be mentioned that shampooing paralysed muscles, and the use of electricity, will delay decay and its more serious results for a considerable time, while morphia injected under the skin will relieve pain.

Of course proper treatment of fractures and dislocations *from the moment of their occurrence* will do much to prevent such evils, by guarding the nerves and other structures from injury after the accident in the way described on page 37; while the accurate bringing together of the edges of a wound, and keeping them together, is as necessary for union of cut nerves as for other tissues. (See WOUNDS.)

Tumours, growths of various sizes from that of a pea to that of a hen's egg, and of various kinds, may occur in the brain, spinal cord, or other parts of the nervous system.

The symptoms may be very varied—giddiness, headache, vomiting, pain, convulsions, paralysis, if the tumour be in the brain. Pain and paralysis are likely to be the chief symptoms in other nervous regions. It is impossible, however, to discuss the symptoms of such a disorder in this work.

Syphilis is an important cause of tumour in the brain, and reference should be made to that disease.

SECTION VI.—THE DIGESTIVE SYSTEM.

A.—ITS ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

General Sketch of the Digestive System:—

The Alimentary Canal—its various divisions:

The cavity of the abdomen—its organs; and their relative positions; the peritoneum and mesentery:

Food—

The necessity for food—the kind of food required—the destination of food—the purpose of digestion.

The Digestive Apparatus:—

The Mouth, Teeth—their kinds and structure, *the tongue* and *salivary glands:*

The *pharynx* and *gullet:*

The *stomach*—its coats and glands:

The *small intestine*—its divisions (duodenum, jejunum, ileum), its glands and villi:

The *large intestine:*

The *blood-vessels of the alimentary canal*—the portal vein:

The liver—its structure, blood-vessels, and bile-ducts—the gall-bladder:

The *pancreas* or sweet-bread.

The Digestive Process

in the mouth—mastication (chewing), insalivation (mixture of food with saliva), the nature and action of saliva, deglutition (swallowing),

in the stomach—gastric juice, its nature and actions, artificial digestion, conditions of digestion, time required for digestion, absorption by the stomach,

in the small intestine—the nature and actions of pancreatic juice, bile, and intestinal juice, absorption by the small intestine,

in the large intestine—the fæces.

Hunger and Thirst. Functions of Liver.

General Sketch.—The digestive system includes all those organs that are connected with the function of **alimentation**, the function, that is, which has to do with the preparation of food to fit it for gaining entrance into the blood, and with the separation of the nourishing from the not-nourishing portions of the food. What exactly all this includes will be most readily understood by an outline of the course taken by the food from the moment that it enters the mouth, and of the processes through which it passes till all the nourishment is obtained from it that is necessary.

The food taken into the mouth is bruised and broken down by the teeth, being rolled about in the mouth as well, and mixed with a fluid—the **saliva**—which is poured out by certain glands in the walls of the mouth and their neighbourhood—the salivary glands. Then, made up into a mass and well moistened, it is forced into the back part of the mouth, mainly by the action of the tongue, and then carried by muscular movements, constituting swallowing, into the gullet, down which it passes to reach the stomach. Arrived in the stomach it is submitted to the action of a new fluid—the **gastric juice**—whose operation is aided by the heat of the parts and by a slow movement which propels it round and round the bag of the stomach. After the lapse of some time, from one to three or four hours, the process in the stomach is completed, and the food has become converted into a more or less fluid mixture called **chyme**. Some of its nourishing elements without delay pass out of it into the blood-vessels which line the walls of the stomach; the rest escapes from the stomach into the canal of the small intestine, where it at once meets with three other juices—the **bile**, from the **liver**, the **pancreatic juice**, from the **pancreas** or **sweet-bread**, and the **intestinal juice**, poured out from the wall of the intestine itself—which attack the substances that have escaped the action of the gastric juice. Along the canal of the intestine the chyme is propelled, forced onwards by gentle circular contractions of the

walls of the canal; and all along its course there are being slowly abstracted from it all the nourishing elements it possesses. From the small intestine the remains of the food pass into the large intestine, along which they proceed much more slowly owing to the form of the large bowel. During their slow progress much of the watery material that remains is removed, and finally the waste matters, having obtained some degree of consistency, accumulate in a dilated portion at the end of the large bowel, termed the **rectum**, till they are expelled by an effort of will. We have then to consider in detail the alimentary tract or canal extending from the mouth to the end of the rectum, the juices met with at various intervals, the glands which produce them, and the actions they exert upon the food, and the means by which the digested food is made to give up its nourishing portion to the blood.

The **alimentary canal** is the anatomical name given to the whole length of the canal or passage along which the food is carried. Its average length in the adult is about thirty feet, or about five or six times the length of the body. The mouth, with the teeth and salivary glands, is situated in the head; the gullet, whose upper wide portion situated at the back of the mouth is called the **pharynx**, is chiefly in the cavity of the chest, lying against the back-bone; and it passes through the muscular partition that separates the chest from the belly—the **diaphragm**—to open into the stomach. The stomach and remaining portions of the canal are placed in the cavity of the belly, which conceals them, and which is therefore called the **abdomen** (Latin *abdere*, to conceal).

The appearance and position of the different parts of the alimentary canal will be better understood by referring to the accompanying wood-cut and description (Fig. 86).

The opening out of the rectum (n) on the surface of the body is called the **anus**. At this place there is a double narrowing, caused by circular bands of muscular fibre round the canal. These bands form what is called the sphincter of the anus, and prevent the accumulated matters in the rectum passing out until they are relaxed by an effort of will.

Observe that the bend at the sigmoid flexure (m) helps to relieve the rectum and sphincter of the anus of the pressure of the matter contained in the descending part of the large bowel. Without that relief there might be difficulty in maintaining the closure of the sphincter.

The **cavity of the abdomen** has been spoken of. It is formed of muscular walls which, directly or indirectly, are supported by the back-bone behind and by the ribs above and the haunch-bones below. In the middle of the back wall of the cavity is the back-bone, but

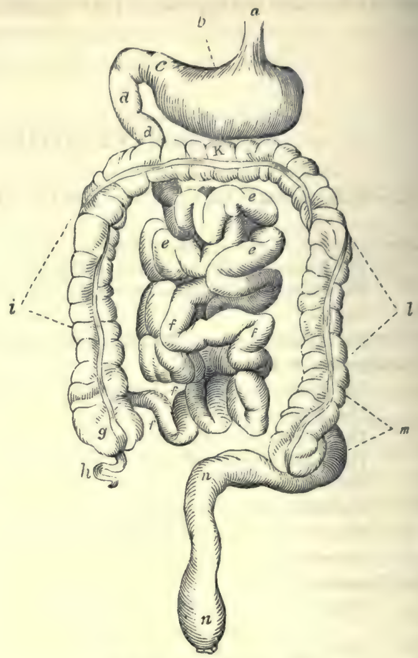


Fig. 86.—The Alimentary Canal.

a, The gullet, or œsophagus, which is continued from the back part of the mouth to

b, The stomach.

c, The pylorus, the small end of the stomach where it opens into the first part of the small intestine. At the pylorus is a thickened portion of the stomach wall, which acts as a valve to prevent the food leaving the stomach till the proper time.

d d, The duodenum or commencement of the small intestine.

e e e, The second part of the small intestine, called the jejunum.

f f f f, The third and terminal portion of the small intestine, termed the ileum (from Gr. *eilō*, to roll). This must not be confounded with the part of the haunch-bone called the *ilium* (p. 22).

g, The cæcum. This is the commencement of the large intestine, and between it and the ileum there exists a valve which prevents the return of any of the contents of the large intestines back into the small. This is called the ileo-cæcal valve.

h, A round worm-like process of the cæcum, which is termed the vermiform process.

i, The first portion of the large intestine, called the ascending colon.

K, The transverse colon.

l, The descending colon.

m, A part of the large intestine which is curved on itself, somewhat in the form of the letter S, and termed the sigmoid flexure of the colon.

n, The termination of the large intestine and alimentary canal, named the rectum.

it is covered over, and its irregularities and hardnesses masked by muscle and other soft tissues. Now it must not be supposed from the diagram (Fig. 86) that the intestines lie in a loose heap in this cavity. Lining the cavity, just as, to use a very rough figure, a paper lines the walls of a room, lining the walls of the cavity is a delicate fibrous membrane called the **peritoneum**. When the peritoneum in its course of lining the walls comes in contact with the large bowel it passes

over it, just as the paper of a room would pass over, say a gas-pipe which ran along the surface of a wall, and in passing over the large bowel it binds it down to the wall of the cavity. The small bowel is, however, not lying against the wall of the cavity as is the large one, it is out towards the centre of the space. In order to reach it, therefore, the peritoneum from its course over the back wall passes out to reach the small bowel, passes round it so as completely to envelop it, and then passes back to the wall again to continue its course. Thus there is a double fold formed by the membrane as it passes out and as it passes back, and this double fold suspends the small bowel from the back wall of the cavity. It is called the **mesentery.** Besides the stomach and bowels the abdomen contains other organs, the **liver, spleen** (melt), **pancreas** (sweet-bread), **kidneys,** and low down in the pelvis the **bladder** and **generative organs.** The positions of these other organs will be referred to immediately, and will be more fully stated when each comes to be discussed. The general position which most of the organs named occupy can be roughly made out from the outside. Take the succeeding figure (87) and study it in relation to Fig. 86. It represents the front wall of the belly as mapped out into regions by the lines shown on the figure. The regions are marked off by drawing two cross lines, one connecting the lower edge of the ribs on each side, and the other by connecting the highest point of the haunch-bone on each side. The two upright lines are drawn straight upwards from the middle point of the groin on each side. There are thus marked off nine regions, each one being called by a special name, the advantage of them consisting in the list, which anatomists are able to draw up for the guidance of physicians and surgeons, of the different organs which are found to lie beneath each region.

The first region is called **epigastric** (Greek, *epi*, upon, and *gastēr*, the stomach), because it is over the stomach; the second, immediately below it, is **umbilical**, because it incloses the umbilicus or navel, and the third **hypogastric** (*hupo*, under, and *gastēr*), because it is below the stomach. These are the middle divisions. On the left side, the fifth division is left **hypochondriac** (Greek, *hupo*, under, and *chondros*), because it is the region under the ribs. Below it is the seventh division—the **lumbar** region, and next is the ninth—the **iliac** region, because the region of the ilium or flank-bone (Latin, *ilia*, the flank), the name for the chief portion of the haunch-bone (p. 22). Similar names apply to similar regions on the right side, right being substituted for left. By referring to page 22 it will be seen that these three lower divisions, namely, the 3rd, 8th, and 9th, are ranged round the upper edge of the pelvic bones, and that beneath them is the cavity of the pelvis—the lower portion of the belly—which has no region marked externally corresponding to it. As already noted, in this lower cavity lie the genito-urinary organs.

These points being understood, by consulting the following list it will be seen how one could with some ease determine the position of any particular organ from the outside. Or, again, suppose a person to be suffering from pain or swelling at a limited part of the belly, by referring to the list some idea would be gained of the organ or portion of organ that was probably affected.

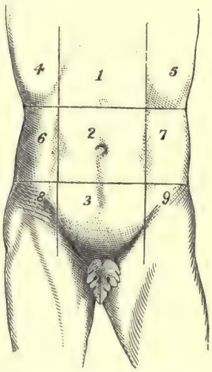


Fig. 87.—The Regions of the Belly.

1. *Epigastric Region.*—The right part of the stomach, the pancreas or sweet-bread, and part of the liver.
2. *Umbilical Region.*—Transverse colon, part of duodenum, with some convolutions of jejunum and ileum.
3. *Hypogastric Region.*—Convolutions of lower part of small intestine, the bladder in children and in adults if distended, and the womb in females when enlarged.
4. *Right Hypochondriac Region.*—Right lobe of liver and gall-bladder, part of the duodenum and of ascending colon, upper part of right kidney.
5. *Left Hypochondriac Region.*—Large end of stomach, spleen, narrow part of pancreas or sweet-bread, part of colon, upper part of left kidney.
6. *Right Lumbar Region.*—Ascending colon, right kidney, and part of small intestine.
7. *Left Lumbar Region.*—Descending colon, left kidney, and part of small intestine.
8. *Right Iliac Region.*—The cæcum or commencement of large intestine, and termination of the small intestine.
9. *Left Iliac Region.*—Sigmoid flexure of colon.

The rectum lies in the pelvis.

Food.

It is not intended at this place to discuss all that is included under the general heading Food. That is delayed to the part of the work devoted to Hygiene, where information will be given about the various kinds of food stuffs of

a more detailed character. Only what is necessary for the understanding of the process and purpose of digestion will be considered here.

The Necessity for Food.—In the Introduction a healthy man has been compared to a steam-engine in thorough working order. It has been seen that as an engine uses up fuel and water for the purpose of obtaining from them the force necessary to perform its work, so a man consumes certain substances in order to obtain from them the force necessary for his life and activity, and that these substances he obtains from the blood. In short, a man by the daily work of his body, whether that work implies merely the movements of heart and chest, the maintenance of the heat of the body, and so on, just what is necessary for life, or implies besides manual or mental labour, a man by the daily work of his life consumes certain parts of his body. Waste goes on within his body. Suppose the waste were allowed to continue, no effort being made to supply the place of what had been consumed, the man would continue to live and work at the expense of his own body. This could not long be endured without danger. The waste must, therefore, be repaired, and food is the means by which this is accomplished. Let us see now what is the nature of the waste. An ordinarily healthy man passes out of his bowels daily, on an average, 5½ oz. of material, a large proportion of which—not less than 75 per cent. indeed—may be considered water, by the kidneys, 56 oz., 96 per cent. of which is water, by the skin, in the shape of sweat, a variable quantity, 23 oz. or thereby, of which 99 per cent. is water, and by the lungs 34 oz., of which 10 oz. are water and the remainder carbonic acid gas. Therefore, setting aside for the moment the 25 per cent. of the solid matter removed from the bowels, which will be mainly indigestible or undigested remains of the food, setting that aside, the main bulk of what a man passes out of his body daily consists of water, carbonic acid gas, and certain solid matters contained in solution in the urine, sweat, &c. Now, the chief of these solid matters is a substance found in the urine called urea. Urea is made up of the four elements carbon, hydrogen, oxygen, and nitrogen. Water contains only two elements, hydrogen and oxygen, and carbonic acid also only two, carbon and oxygen. It appears, therefore, that what a man casts out of his body daily consists essentially of four elements, carbon, hydrogen, oxygen, and nitrogen. Now these four elements cast out of the body in the shape mainly of water, carbonic acid gas, and urea, represent the consumption that has been going on in the body to produce the force necessary for the man's life, even as the smoke, ashes, and steam represent the consumption of fuel and water going on in the steam-engine. It is, consequently, evident that if one could restore to the body daily a quantity of those four elements similar to that cast out one would be able to make up for the waste that had been produced. The purpose of food, then, is to restore an amount of the four elements equal to that used up, to repair the waste.

The **kind of food** required. One would imagine that if a meal were set down to a man consisting of so many ounces of carbon (charcoal), so many ounces of hydrogen gas, so many of nitrogen gas, and so many of oxygen, he would have all that was required to maintain his strength. But man, in common with other animals, is unable to take the elements, the raw elements, in this way, and make use of them. He needs to have the elements put into combinations that will suit his peculiar organization. Plants are able to take the elements up, however, and transform them into the living substance of their own bodies. Plants combine them, that is to say, for the benefit of man and the rest of the animal kingdom; and then men and animals make use of plants for food, corn, wheat, barley, potatoes, and so on, and so obtain the elements in a combined state which they could not make use of in the simple state. So that the question comes to be, is there a substance containing the four elements named which man can use as a food to repair the waste of his tissues? There is a class of substances, called **Proteids**, which contain all four elements, carbon, hydrogen, oxygen, nitrogen. They are also called **albuminous** substances, because a type of the class is **albumen**—white of egg. Belonging to the same class is a substance called **gelatine**, obtained by boiling tendons and connective tissues, another called **chondrin**, yielded by boiling cartilage (gristle). Another of the class is found in flour, called **gluten**; and in peas or beans is still another, **legumin**. The curd of milk, from which cheese is made, consists mainly of an albuminous body—**casein**, and from flesh is found another of the class, namely, **myosin**. So that all four elements one could obtain from a quantity of white of egg, curd of milk, or meat. So one might well ask the question, since an albuminous body contains all the required elements, can a man not live on, for example, white of egg alone, or lean

meat alone, or a diet of beans or peas alone? Well, an American physician, Dr. Hammond, in 1857 tried some experiments on himself, and limited himself to 1½ lb. of albumen daily, with 4 lbs. of distilled water. On the fourth day he began to experience loss of appetite, headache, and weakness. His disgust at the perpetual sameness and tastelessness of the diet became almost unbearable, and on the ninth day, after severe diarrhœa, he had to give it up. Now, this is not to be wondered at, considering the tastelessness of the diet; but albumen might be made to form the chief portion of the diet, but might be given in a much more palatable form, and might be varied—white of egg one day, lean meat another. Still the attempt to live on an albuminous diet alone would be very difficult to accomplish, for a reason that will now be given. The total quantity of nitrogen cast out of the body daily by a man under ordinary circumstances is 300 grains, of carbon about 5000 grains. The quantity of hydrogen and oxygen cast out are replaced by oxygen obtained from the air he breathes, of which he will take into his body by his lungs about 2 lbs. weight daily, and by water, which contains oxygen united with hydrogen, of which 60 to 70 oz. per day are sufficient. Thus, supposing a man to have pure air to breathe and water to drink, he requires 300 grains nitrogen and 5000 grains carbon; that is, 15 grains of carbon for every 1 of nitrogen. In albumen, however, the proportion of nitrogen to carbon is 1 to 3½ instead of 1 to 15, which is as much as to say that a man who sought to live on albumen would get in his food a proportion of 1050 grains (instead of 5000) of carbon for every 300 of nitrogen. In other words, in order to secure his 5000 grains of carbon he would require to take a quantity of albumen that would yield him that amount. But this quantity yields also 1428 grains of nitrogen, which are 1128 more than he requires. So that to live on albumen alone he needs a quantity that gives him far too much nitrogen, for which he has no use, and which casts labour on his body to get rid of the excess. To take an example, one would require to eat 4 to 5 lbs. of lean meat to get 5000 grains of carbon, while 1 lb. will yield the required nitrogen. To eat 5 lbs. of meat would mean immense unnecessary labour cast on the digestive organs. Only an albuminous body, however, will yield nitrogen in a condition to be made use of by man, and we are, therefore, face to face with the next problem, is there any other class of foods which could be mixed with the albuminous so as to get the required carbon and nitrogen in the most economic way? The class of food stuffs to which fat belongs contains carbon, hydrogen, and oxygen, without any nitrogen, and a class called amyloid or carbohydrates, to which sugar, starch, and gum belong, contain the same three elements without any nitrogen. We thus see that by taking a quantity of lean meat or white of egg just sufficient to supply 300 grains of nitrogen the addition to it of a certain quantity of sugar, starch, or fat will provide the necessary carbon without increasing the nitrogen. Or to take a better example, bread contains carbon in the shape of sugar and starchy matters, and albumen in the shape of the gluten of the flour. It has all the requisite elements, therefore, but in it the quantity of nitrogen is small in comparison to the quantity of carbon. Enough carbon could be obtained out of 2 lbs. of bread, but this quantity would yield only half the amount of nitrogen, so that 4 lbs. of bread would be required to yield a sufficient amount of nitrogen, and that would contain double the carbon necessary. Thus bread has the carbon in abundance, but is deficient in the nitrogen, and lean meat has the nitrogen in abundance but is deficient in the carbon. Unite the two, and you have as a result that 2 lbs. of bread yield very nearly the required amount of carbon and half the required nitrogen, and ¾ lb. of lean meat yield the other half of the required nitrogen and a small quantity of carbon, sufficient to swell that obtained from the bread to the full amount required. A combination, then, of two different kinds of food stuffs, in proper proportions, yields the required substances for repairing the waste of the body, while it throws the least possible amount of work on the body for their digestion. In this consists the economy of a mixed diet. One of the most admirably proportioned of human diets is milk, which contains albumen in the form of curd (casein), that is the nitrogen, and the carbon in the form of fat (the cream) and sugar (the sugar of milk). These are dissolved in water, all in due proportion, and thus we have a type of a food fitted not only by its ingredients for the nourishment of the body, but by its form for easy and rapid digestion and passing into the blood.

It is now necessary to remark that there are cast out of the body, besides substances containing the four elements mentioned, other substances belonging to the mineral kingdom—saline bodies, chief of which are salts of soda and potassium, and particularly chloride of

sodium (common salt). These must also be replaced. Bread invariably contains such salts, so also does milk, meat as well.

To sum up, then, we see that to replace waste there must be introduced daily into the body a certain quantity of water, a certain quantity of solid food containing albumen, and fat, or starch, or sugar, and a small proportion of saline material, and a certain quantity of oxygen gas taken in by the lungs. The quantity of water has already been stated as between 60 and 70 oz. daily, and the quantity of solid food ought to be 28 oz. This is the least quantity that is consistent with maintenance of vigour for an ordinarily healthy man doing an average amount of work.

[For information about the nourishing qualities of various sorts of food, and other similar information, refer to *Food* in the part devoted to HYGIENE.]

The destination of food. The purpose of food, it has been seen, is to repair the waste going on continually in the body. The waste occurs in no one part in particular, but in all the tissues of the body. The contraction of a muscle necessary to move a limb means the using up of some portion at least of the fibres of muscle, the waste, that is, of some of the elements which go to make up the contracting muscle. The beating of the heart means the same thing, the perpetual consumption of some of the particles which go to make up the heart's substance. The activity of the liver means the constant breaking down of the small cells of which the liver is composed. Thinking, feeling, willing, imagining, in the same way are all attended by the waste of nervous tissue. So it is with every organ and tissue of the body.

Every one of these tissues comes into direct contact with the blood. Every organ has its blood supply conveyed to it by vessels large or small according to the size and activity of the organ. The blood-vessel has no sooner entered into the organ or tissue than it breaks up into a number of branches, which in turn send off countless tiny streams that flow through the tissue, pervading it in every direction. As a result the ultimate cells or fibres which form the tissue are constantly bathed by the streams that continually flow past them. The cells and fibres are continually wasting, and the stream of blood as continually brings to them the means of repair. It offers to them the raw material needed for their continued industry; and they are able to select from the passing current whatever they require to repair their waste and to provide for their renewed activity. At the same time, as the current goes past it is a convenient channel for the removal of the products of waste, that must not be allowed to remain in the tissues. The waste, then, occurs in the tissues, the means of its repair are obtained from the blood. In the end it is the blood that is impoverished. From it the drain of nourishment takes place. So long as it is of proper strength and in proper quantity the renewal for the wasted tissues is provided. So that due provision is made for the nourishment of the tissues if a proper condition of the blood is maintained. Thus the food we take is first of all directed to renewing the blood and maintaining its efficiency. While, then, the purpose of the food is for the repair of waste, its immediate destination is the blood. How does it get there? is naturally the question. It must pass into the blood-vessels out of the cavity of the stomach and the canal of the intestine; but how? There are no visible openings communicating with this canal on the one hand and the blood stream on the other. There is no vessel or channel which acts as a medium of communication between the two.

In 1837 a Frenchman named Dutrochet described some remarkable experiments made by him. He found that if he took a tube open at both ends, one end being of a bulb shape, and if he closed the bulb-shaped end with a piece of animal membrane, a piece of bladder, for instance, then filled the bulb and tube with a strong solution of salt, and dipped it into a glass jar containing water, two currents were set up through the membrane. A current of water passed from outside through the membrane into the salt solution, so increasing the quantity of liquid on that side that it rose in the tube. At the same time salt in solution passed through the membrane into the water outside and could be detected there very soon. Anyone can repeat this experiment for himself, and, provided the solution be strong enough and the bulb be kept dipping in the water outside, the liquid will continue to rise in the tube of the bulb for days, so that many feet of tubing have to be added, end to end. At the close of the experiment a very large quantity of the salt will be found to have passed into the water outside. The process by which the water passes through the membrane into the bulb is called **endosmosis**. Since the days of Dutrochet many experiments have been made of a similar kind. Sugar and salts of all kinds are

capable of producing the currents and of passing in solution through animal membranes. Instead of the water a solution of salt may be placed in the jar outside, and, provided the strength of the outer and inner solutions is different, the same interchange will go on through the membrane, or solutions of two different substances may be used with a like result. The general result may be put in this way, whenever there are two different solutions separated only by an animal membrane an interchange will take place between them through the membrane.

Now let this be applied. In the stomach and intestinal canal there is a quantity of liquid food, to a great extent a liquid containing many substances in solution. In the walls of the stomach and bowels there is flowing a stream of blood, another liquid containing many substances in solution. These two liquids are separated from one another by the extremely thin walls of the channels along which the blood flows, and by a thin portion of the wall of the intestinal canal, in short, by an animal membrane. The liquid in the alimentary canal contains a much larger quantity of dissolved substances than the blood. The inevitable result will be that an interchange will take place between the blood and the contents of the stomach and bowels, resulting in the passing through the wall of the intestinal canal into the blood of the dissolved substances of the food. A continuation of the experiments of Dutrochet, especially those made by Graham, the late Master of the Mint, throws further light on this subject.

The purpose of digestion. The experiments show that while substances like sugar and salt readily pass through the animal membrane, other substances like albumen, starch, gum, and fat pass through with great difficulty, indeed hardly at all. Suppose into the bulb closed by the animal membrane a solution of salt, starch, sugar, and white of egg be placed, and then the bulb dipped into the jar of water. After some time, if the water outside be in sufficient quantity, all the salt and sugar will be found to have passed out of the bulb, but none of the starch or white of egg, which are still retained. Accordingly, when one takes a meal of bread and meat the contents of the stomach will consist of a liquid containing albumen obtained both from the meat and bread, fat from the meat, starch and sugar from the bread, and salts of various kinds from both. The sugar and salt will readily pass through the animal membrane of the intestinal walls into the blood, but the albumen, fat, and starch never will. Yet as it is absolutely necessary that they also gain entrance to the blood, it is obvious that they must undergo some change that will confer on them the power of passing through animal membranes. Now starch can be converted into sugar, and sugar can pass through membranes, and albumen can be converted into a substance called peptone, which also can pass through membranes. The power of converting starch into sugar is possessed by the saliva from the salivary glands, and by the juice poured into the bowel from the pancreas (sweet-bread), and the power of converting albumen into peptone is possessed by the gastric juice poured out from glands in the walls of the stomach and by the juice from the pancreas as well. Fat, again, cannot pass through a membrane, but fat and soda make a soap. Now the bile is an alkaline fluid, it contains a large quantity of soda salts. It mixes with the fat in the small intestine, and so saponifies it—makes it soap-like—that it becomes possible for it also to pass through a membrane. The story of digestion is practically this, then, that the food we take must get into the blood, but to get there it must pass through the walls of the stomach or bowel, interposed between it and the blood; to pass through these walls it must first be made into a solution, so the food is broken down by the teeth and mixed with fluids poured into it from various glands: with no further change the salts, sugar, and similar substances can pass at once through the animal membrane into the blood, but the albumen, fat, and starch cannot: they are, therefore, acted on by the juices till they are converted into substances that can pass. The whole purpose of digestion is, therefore, to make the food into a condition that will enable its nourishing elements, albumen, fat, starch, sugar, and salts, to pass into the current of blood circulating in the walls of the stomach and intestines.

Having thus attempted to understand in a general way why food is needed, and what is the meaning of digestion, we shall proceed more particularly to consider in proper order the details of the digestive process and the organs concerned in it.

The Digestive Apparatus.

The Mouth is a cavity formed by the lips in front, cheeks at the side, tongue below, and palate above. The roof of the mouth derives its bony part from the upper jaw-bone on each

side and the palate bones behind (see p. 18); the bone is covered by the mucous membrane (c, Fig. 88) of the mouth. Reference to Fig. 88 will show

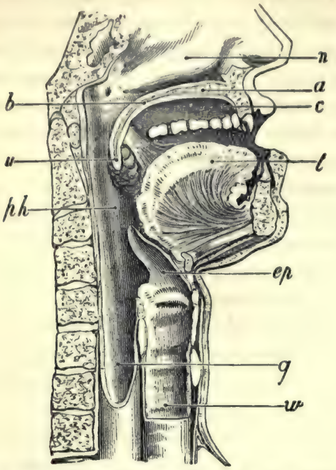


Fig. 88.—Section showing Mouth and Nasal Cavities, Gullet, Windpipe, &c.

t, tongue; *ph*, pharynx; *ep*, epiglottis; *g*, gullet; *w*, windpipe. For other references see text.

that the bone (a) forms only the front portion of the palate—the hard palate as it is called, for the bone stops short at b, and the continuation is effected by mucous membrane and muscular substance as the soft palate, of which the uvula (u) is a part. The hard and soft palates form not only the roof of the mouth but also the floor of the cavity of the nose (n, Fig. 88), so that they partition off the nose from the mouth. Now sometimes this partition is not properly developed, and a cleft exists in the soft palate. The cleft may extend forwards some distance and may involve the hard palate, so that the partition is incomplete and an opening more or less wide permits of an unusual means of communication between the mouth and nose. The result is a very serious defect of speech, the air being sent up into the nose. The mouth is continued behind into the throat, the separation between mouth and throat being marked by a narrowing, called the **isthmus of the fauces.** This constriction is formed of fleshy pillars—the pillars of the *fauces*—which arch up from the sides to form the **soft palate or velum**; and from their meeting place in the middle of the arch there hangs down a portion, termed the **uvula** (u). At each side, where the pillars begin to arch up, is an almond-shaped body—the **tonsil**, which ought not to be prominent at all, but which swells and projects towards the middle line in inflamed throat, threatening often to block the way from the mouth into the throat. The tonsil is seen in the figure partly coverd by the uvula. The whole mouth is lined with *mucous membrane.* This membrane is really in its essence the same as the skin which lines all the external parts of the body. On referring to the section on the SKIN it will be seen to be of two layers—a deep one of a fibrous structure, rich in blood-vessels and nerves, and one on the surface of this, consisting of cells only with no vessels or nerves. In mucous membrane the same two layers are found, only they are more delicate and soft. At all the openings of the body the skin becomes modified into mucous membrane, which takes its place and lines all the cavities and channels of the body which communicate with the exterior. The mucous membrane of the mouth is, therefore, continuous with that of the throat, gullet, stomach, and bowels. It is beset with little glands which pour out a fluid to moisten the mouth.

The teeth are imbedded in sockets in the upper and lower jaw-bones. Each tooth consists of a **crown**, the visible part, and one or more **fangs** buried in the socket. The teeth are thirty-two in all, sixteen in the upper, and the same number in the lower jaw. They differ in form from one another, and have different names according to their use. Thus the four central teeth of each jaw have chisel-shaped crowns with sharp cutting edges, and are called, on this account, **incisors**; they have but a single fang. On each side of these central four is one tooth with pointed extremity, the tooth developed in dogs and other animals for holding and tearing—the **canine** tooth (Latin *canis*, a dog). The upper two are also called **eye-teeth.** Behind the canine teeth there follow on each side two **bicuspid** teeth, teeth with two cusps or points instead of one, and having often double fangs; and succeeding them are the **molars** or grinders, three on each side, broad teeth with four or five points on each, and with two or three fangs.

The following table shows the teeth in their order:—

	Mo.	Bi.	Ca.	In.	In.	Ca.	Bi.	Mo.		
Upper jaw,	3	2	1	2	2	1	2	3	=16	= 32.
Lower jaw,	3	2	1	2	2	1	2	3	=16	

The upright line indicates the middle line of the jaw, and shows that on each side of each jaw there are eight teeth. These are the **permanent set**, which succeeds the **milk-teeth.** At about the sixth year of a child's life the milk teeth begin to fall away and give place to the permanent teeth, which appear in the following order:—

Molar, first	6 years.
Incisors	7 to 8 ,,
Bicuspids	9 to 10 ,,
Canines	11 to 12 ,,
Molars, second	12 to 13 ,,
,, third	17 to 25 ,,

The first of the permanent set to appear is thus the first grinding tooth; and it appears above the gum behind the farthest back of the milk-teeth. The last to appear are the last grinding teeth, which, owing to their lateness of arrival above the gums, have been called the **wisdom teeth.** In some people they never appear above the gum at all.

Structure of Teeth. Fig. 89 represents the appearance on a cut being carried straight down through a tooth in its socket. In the very centre of the tooth is a cavity—**the pulp cavity** (*f*)—which is filled up with the **dental pulp,** a soft substance containing a rich supply of blood-vessels and nerves. The vessels and nerves enter by a small opening at the point of the fang. In teeth with two or more fangs the cavity is prolonged in the shape of a fine canal down each fang, to a little opening at the point of each. Surrounding the cavity on all sides is the substance that forms the main part of the tooth—the **dentine** (*b*). It consists of fine branching tubes embedded in a hard substance. The tubes contain substance continuous with the pulp of the tooth cavity. Dentine is very hard but not brittle, consisting mostly of phosphate and carbonate of lime. Ivory is the dentine of the elephant's tusk. Outside the dentine of the fang is a substance closely resembling bone, and called **crusta petrosa** or **cement** (*c*). In fact it is true bone, but wants the haversian canals (see p. 18). The fang is fixed in its bony socket (*e*) by means of a dense fibrous membrane (*d*) which surrounds the cement as the periosteum does bone. The dentine of the crown of the tooth is not covered by cement but by the **enamel** (*a*), which consists of closely set prisms of a densely hard substance, composed mainly of phosphate of lime and other earthy salts and only 3½ per cent. of animal matter. In young teeth the surface of the enamel is covered by a delicate membrane, which answers to the popular term "the skin of the teeth." It is worn off in adult teeth.

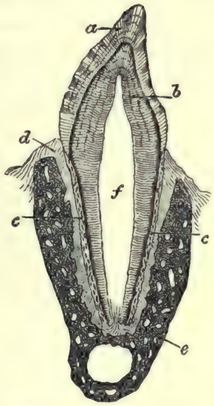


Fig. 89.—Structure of Tooth.

The Tongue (*t*, Fig. 88) is a muscular organ, and is covered by the same membrane that lines the rest of the mouth. On the under surface the membrane forms a fold in the middle line, passing between the tongue and the front of the lower jaw. This fold is sometimes continuous to the tip of the tongue, binding it down and interfering with speech, and in infants with sucking. The upper surface is covered with little projections—the papillæ of the tongue, which are connected with taste, and will be considered in the section on TASTE.

The **Salivary Glands** are three in number on each side of the mouth. Their position is shown in Fig. 90. The **parotid** gland is situated on the side of the face in front of the ear; the **submaxillary** is placed below and to the inner side of the lower jaw, in front of the angle of the jaw; and the **sublingual** is on the floor of the mouth between the tongue and gums. The two sublingual glands are thus near to one another, one on each side of the fold beneath the tongue. All these glands belong to the class called **racemose,** from their resemblance to a bunch of grapes. They have little channels or ducts, which give off smaller and smaller branches, the smallest branches ending in little pouches or sacs lined with cells, as the stem of the vine gives off smaller stems which end in the pouch of the grape. Groups of the little pouches are bound together by connective tissue, through which blood-vessels pass. Thus the blood stream is brought so near to the cells of the pouch that they can derive from it whatever materials they need for their nourishment and activity. From the blood the cells derive the raw material which they work up into the substance which it is their business to produce. This substance—the **saliva**—is then conveyed along the small channels or ducts till the common duct is reached which carries the fluid into the

Fig. 90.—The Salivary Glands:
P P' Parotid, *s m* sub-maxillary. *d* is placed below the duct of the parotid.

mouth. Nerves are also freely distributed to the glands, and it has been found that the activity of the gland is largely regulated by the nerves. Fine filaments of nerves have even been traced to the very cells that line the pouches of the gland. The main duct which conveys away the fluid saliva from the parotid gland (Stenson's duct) opens on the inner surface of the cheek on a level with the crown of the second molar tooth of the upper jaw, where it may be often felt as a slight swelling. The duct of the submaxillary gland (Wharton's duct) opens at the summit of a soft papilla under the tongue. The ducts of the two glands —one of each side—are readily seen on turning up the tip of the tongue. The sublingual glands have a considerable number of ducts opening in the neighbourhood of Wharton's. The purpose of the fluids poured into the mouth from these glands is discussed further on.

The **Pharynx** is the upper end of the alimentary canal, and it forms a blind sac above the level of the mouth (*ph*, Fig. 88). The mouth opens into it, and straight above that opening there are two openings, by means of which the nasal cavity communicates with the pharynx. About the same level as the openings into the nasal passages are two apertures, one at each side, which are the mouths of the Eustachian tubes, which pass upwards to the cavities of the ears, the cavity of each side being on the inner side of the drum of the ear. By referring to Fig. 88 it will also be seen that the windpipe opens upwards into the pharynx, but that this communication can be shut off by the lid of the windpipe (*ep*)—the epiglottis—folding down. Thus there are six openings into the pharynx, and the gullet is the direct continuation of it downwards to the stomach. When one opens the mouth widely before a glass, the back wall seen through the narrowing of the fauces is the wall of the pharynx. The mucous membrane of the pharynx is continuous forwards with that of the mouth, upwards with that of the nostrils and tubes leading to the middle ear, and downwards with that of the windpipe and gullet. It is thus that an inflamed and swollen condition of that membrane, which may have begun as a sore throat, may travel into the nose, may impede the passage of air into the Eustachian tubes, blocking them, and so producing deafness, and down into the windpipe, causing irritable throat and coughing. In the membrane is a large number of glands, the excessive secretion and enlargement of which are so troublesome in relaxed and other conditions of the throat.

The **Gullet or Œsophagus** (*g*, Fig. 88) is the continuation of the pharynx downwards to the stomach. It is about 9 or 10 inches long, and lies behind the windpipe in the neck and upper part of the chest. It passes through the chest, pierces the muscular partition dividing off the cavities of chest and belly, and opens into the stomach. The gullet contains a thick layer of muscular fibres in its walls, which are capable of contracting like other muscular fibres, and so of diminishing the diameter of the tube. As we shall see, it is by such contractions that the food received from the mouth is passed downwards into the stomach.

The **Stomach** is simply to be regarded as a dilated portion of the alimentary canal. Reference to Fig. 87 and its accompanying description show it to occupy a part of the epigastric and left hypochondriac regions of the abdomen. The following figure (91) shows how much of the stomach is in direct contact with the front wall

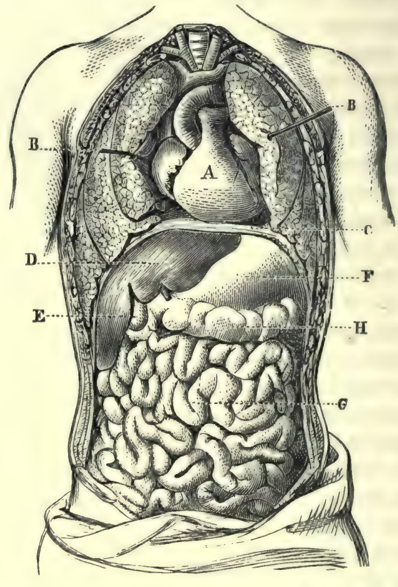


Fig. 91.—The Contents of Chest and Abdomen shown in their Positions.

A, heart; B B, lungs; C, diaphragm, the horizontal partition between chest and belly; D, liver; E, gall-bladder; F, stomach; G, coils of small intestine; H, cross part of large intestine.

of the belly, and how much is covered by the diaphragm (C) above, and the liver (D) to the right. The shape of the stomach is shown in Fig. 86, where A marks the entrance of the gullet, and C the junction of stomach and small intestine. That figure shows it be pear-shaped with the large end to the left and the small end to the right. The large end is called the cardiac end because it is to the heart side. Thus

the main bulk of the stomach is under the ribs to the left side. The walls of the stomach are composed of several layers or coats. The most important of them are the middle coat of muscular fibre of the involuntary kind, whose contractions produce movements of the walls, and the internal coat or mucous layer continuous with the mucous lining of the gullet. The mucous layer is thrown into folds, and thus a wrinkled appearance is presented by the inner surface of the stomach. The surface of the membrane is lined with columnar epithelium (p. 16). The important parts of the mucous lining, however, are the glands, which, in the form of fine wavy tubes, are buried in the substance of the membrane, and open by their mouths on the surface. The appearance of a section of the wall of the stomach when examined by a microscope is seen in Fig. 92; and in the upper corner one of the

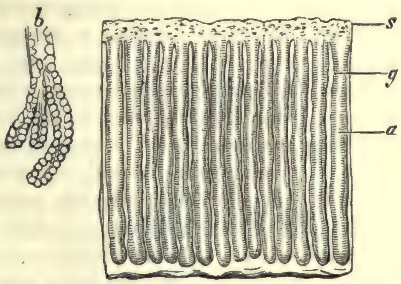


Fig. 92.—The Mucous Membrane of the Stomach, highly magnified. *s* points to the surface, *g* to one of the tubular glands, of which *a* indicates the central canal. *b* is a much more highly magnified view of one gland, which is represented as giving off branches.

tubular glands is represented highly magnified. Each gland is found to be a more or less simple tube lined with columnar cells. **Peptic or gastric glands** they are called. Now in the mucous membrane there runs up between the rows of glands a large number of very minute blood-vessels conveying very fine streams of blood. Thus there are reproduced the conditions observed in the salivary glands, namely, a stream of blood separated by only its thin wall and other fine tissue, including the wall of the gland itself, from actively growing and working cells. The cells find, therefore, within easy reach, a current from which they may abstract what they require for their continued life and activity. It is a curious fact that when the stomach is empty, and therefore doing no work, the mucous membrane, if it could be seen, would be found to be pale; but whenever food enters it the membrane speedily assumes a rosy tint, due to a larger quantity of blood rushing into and dilating the fine vessels that pass up between the glands. A little time after drops of fluid collect at the mouths of the glands and trickle down the walls of the stomach to mix with the food; so that the cells of the glands are thrown into a condition of increased activity by increased quantity of blood supply, and as a result they produce a quantity of fluid—the **gastric juice**—whose purpose is to aid in the digestion of the food. How it does this will be considered further on (p. 143). On looking down on the surface of the stomach with a simple lens little pits or depressions of an irregular form will be seen, and at the bottom of the depressions dark dots; the dark dots are the mouths of the gastric glands.

The **Small Intestine** is continuous with the stomach at its small end. At this point (C of Fig. 86) there is a band of circular muscular fibres which keeps the way of communication closed, acting, therefore, as a valve, and called the **pyloric valve.** At appropriate times the fibres are relaxed, and food digested in the stomach is permitted to pass into the small intestine. The first part of the small bowel, about 12 inches long, is called **duodenum** (Latin *duodecim*, twelve) (C D, Fig. 86). Into this portion, about the middle, there open the bile-duct from the liver, and the duct from the pancreas (sweetbread), a gland which lies behind the stomach, the large end of which fits into the crescentic curve formed by the duodenum. The succeeding portion of the small intestine has been subdivided into **jejunum** and **ileum,** though there is no distinction between these. The ileum is the last part of the small intestine; and it opens into the large bowel lying in the right iliac region (8, Fig. 87, p. 131). The opening is guarded by folds of the mucous membrane forming the **ileo-cæcal valve** to permit the passage of material from the small to the large intestine, but to prevent its backward passage.

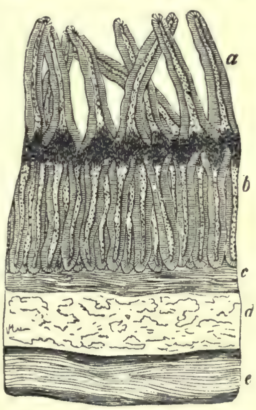


Fig. 93.—Microscopical Structure of the Small Intestine.

The walls of the small intestine consist of similar layers to those of the stomach, but with some remarkable alterations. Like the stomach, the small intestine has muscular layers by whose contraction food in the intestine is propelled onwards. On opening a part of the

small intestine and floating it out in water, the inner coat—the mucous membrane—is seen to be thrown into transverse folds, which are called **valvulæ conniventes**, by which the internal surface of the small bowel is increased. The surface is found to have a velvety feeling, due to innumerable very fine projections termed **villi**. On examining the surface with a microscope these projections take the form of finger-shaped processes from the mucous membrane. They are represented in Fig. 93 (*a*). A very highly magnified view of a single villus is given in Fig. 94, where it is represented as covered with a layer of columnar cells, nucleated. The centre of the projection is formed of very delicate tissue, containing a network of small blood-vessels (*b* and *c*). Besides these, in the very centre is seen a larger vessel (*d*) with a blind extremity. This is the beginning of a **lacteal** vessel, so called because it does not contain blood, but a milk-like fluid (*lac*, milk) obtained from the food in the canal of the intestine. In fact the lacteal is a vessel for absorbing, sucking up, certain of the nourishing parts of the food and conveying them away to other communicating vessels, by which they may finally be poured into the current of blood. This will be referred to again in speaking of absorption. Apart from these projections from the mucous surface, the small intestine presents appearances not unlike those of the stomach. Thus, buried in the substance of the mucous layer, and opening on the surface at the bases of the villi, is a series of tubular glands (Fig. 93, *b*), lined with columnar cells. They are called **Lieberkühn's glands**, after the anatomist who first described them; and they pour out the **intestinal juice**. The bases of the glands rest on a fibrous tissue (*c*, Fig. 93) between them and the muscular layers of the bowel (*d* and *e*). These glands are found throughout the length of the small and large intestines; the villi, however, diminish greatly in number in the lower parts of the small, and are quite absent in the large, intestine. Towards the beginning of the duodenum a few glands, in clusters like grapes, are found. They are called **Brünner's glands**, but their function is not known. Imbedded in the mucous membrane, also, are found groups of little glands, which are in the shape of closed sacs, with no duct or other means of communication with the cavity of the intestine. The closed sacs contain cells and blood-vessels, and are of the size of millet seeds. They are found in patches—**Peyer's patches**—specially towards the lower end of the small intestine, but are also found singly here and there scattered over every part of the intestine.

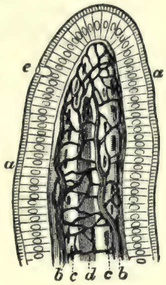


Fig. 94.—Villus of Small Intestine, magnified. *a*, columnar cells; *e*, goblet cell, modified columnar.

The **Large Intestine** begins in the right iliac region. The small intestine joins it at right angles, and not precisely at its extremity, so that a blind end projects beyond the place of junction—the **cæcum** (Latin, *cæcum*, blind). From the place of junction the large intestine passes upwards on the right side, as the **ascending colon**, till the under surface of the liver is reached, where it turns and proceeds across to the left side, as the **transverse colon**, below the stomach. Having reached the left side it turns downwards as the **descending colon** to the sigmoid bend and the rectum (Fig. 86, p. 130). The large intestine is altogether 5 or 6 feet long. It is much wider than the small intestine. The longitudinal muscular fibres are collected into three bundles, which, being shorter than the canal itself, produce a series of pouches or bulgings in the wall, represented in Fig. 86. These pouches delay the progress of the remains of the food, and so permit the nourishing materials to be completely removed. The large intestine possesses no folds like the small, and no villi. It has, however, the glands of Lieberkühn in its mucous coat. Glands of Peyer are also found in the large intestine. The termination of the large intestine at the anus has been already noted on page 130.

The **Blood-vessels** of the abdominal portion of the alimentary canal have rather a peculiar arrangement which it is desirable to note here. The stomach, intestines, spleen, pancreas, and the mesentery as well, all receive pure arterial blood from branches of the main artery that passes down along the front of the backbone. This blood circulates through the various organs in tiny streamlets. In particular it has already been noted that it is from such arterial blood supply that the glands in the stomach and intestines derive the material for their activity. The blood, after passing through the organs, is collected into veins. Thus the stomach has its own set of veins carrying the blood *away* from it; the intestines have their set, the spleen and pancreas likewise. Ultimately, however, the veins from these different organs unite to form one large vessel, **the portal vein**, which passes to the liver. The liver thus receives all the

blood which has previously circulated through the stomach and intestines, which blood, as we shall see, is charged with nourishing material obtained from the food by the process of endosmosis explained on page 134.

The **Liver** must also be counted as a part of the digestive apparatus, since it forms the bile, one of the digestive juices. It is the largest gland in the body, and weighs from 50 to 60 ounces avoirdupois. It is placed just below the diaphragm and on the right side, as may be seen on reference to Fig. 91, p. 138. It extends also across the middle line of the body towards the left side. Its front border reaches just below the border of the chest when a person is sitting or standing; but when the person lies the liver passes slightly up so as to be completely under cover of the ribs, except for a small portion beyond the lower end of the breast-bone. In women by tight lacing the liver is often permanently displaced, forced downwards out of cover of the ribs. This causes crowding in the abdomen and pelvis, and may serve to displace other organs, notably the womb. When a small piece of liver is examined under a microscope it is found to consist mainly of large many-sided cells, containing a large nucleus and a nucleolus. The cells are represented in Fig. 95. The protoplasm of which they consist is very granular, and frequently exhibits a large number of minute bright dots—oil globules. The cells are faintly yellow in colour, and measure the $\frac{1}{1000}$th of an inch in diameter. They are disposed in groups or masses, each little mass being called a *lobule*. When a single lobule is examined it appears to be of an irregularly circular shape, and the cells are arranged in it in rows which seem to radiate from the centre to the circumference of the lobule. It is the lobules that give the liver its coarse granular appearance when torn. It has been mentioned above that the **portal vein** comes to the liver carrying blood full of nourishing material obtained from the stomach and intestines. When this vein reaches the liver it breaks up into branches, which pass into the substance of the organ, giving off smaller and smaller branches as they go. The smallest branches of the portal vein reach the *circumference* of the lobules, and from this surrounding vessel fine streams of blood pass inwards among the cells to the centre of the lobule, where they reunite into one vessel, a branch of what is now called the **hepatic vein** (*hepar*, the liver). The *central* vessels of the lobules unite to produce larger and larger veins till one vessel is formed which carries all the blood *away from* the liver upwards towards the right side of the heart. The portal vein is thus formed by a set of capillary (hair-like) blood-vessels in the stomach, intestines, &c., and splits up into a similar set in the liver, which in their turn give rise to the hepatic vein. It is to be noted that neither of these vessels carries arterial blood. Yet the liver is not without its supply of such pure blood, brought to it by an artery—the **hepatic artery**—which enters the liver and distributes its blood, not to the cells, but to the connective tissue of the bile-ducts and vessels in the organ, the blood afterwards finding its way, like that of the portal vein, into the hepatic vein.

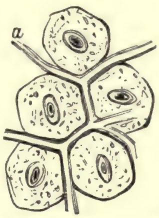


Fig. 95.—Cells of the Liver (very much magnified) with channels (*a*) for the bile between.

Besides these branches of the portal and hepatic veins and hepatic artery another set of vessels ramifies in the liver, namely the **bile-ducts**, whose business it is to carry off the bile produced by the activity of the cells. A very remarkable and interesting experiment, performed by a Polish anatomist named Chrzonszczewsky, shows where the bile-ducts originate. This investigator injected into the veins of some animals a particular dye, indigo-carmine. An hour and a half afterwards the animal was killed, and examination of specimens of the liver under the microscope displayed the colouring matter collected round the cells of the liver in channels which were thus for the first time revealed. If the animal were killed sooner, the colouring matter was found in the cells themselves. It thus became apparent that the liver cells seized upon the colouring matter in the blood brought to them, separated it out, and passed it into channels surrounding them. The channels are shown in Fig. 95 (*a*). They are the beginnings of the bile-ducts. It may be supposed that, in a similar fashion, the cells of the liver take from the blood flowing past them certain materials from which they prepare the bile, which is then discharged into the surrounding ducts. From them the bile passes from between the cells out of the lobule into larger ducts, which collect the bile from numerous lobules. These ducts unite with others from other parts of the liver until, in the end, two channels are formed, one of which carries all the bile formed by the right portion of the liver, and the other that from the left portion.

These two ducts come out from the substance of the liver and soon unite into one main vessel —the **hepatic duct**, which passes towards the small intestine. On the under surface of the liver is the **gall-bladder**, in which the bile may be stored till needed for digestion. From the gall-bladder a duct passes—the **cystic duct**. It joins the duct from the liver, and the **common bile-duct**, formed by the junction of the two, reaches the first part of the small intestine, through whose walls it passes to open on the inner surface a few inches below the stomach. The bile, then, prepared in the depths of the liver by the liver cells, is conveyed out of the liver by the bile-ducts, and may pass straight down and into the small intestine to mingle with the food. If, however, digestion be not going on, the mouth of the bile-duct is closed, and in that case the bile passes up the cystic duct and lodges in the gall-bladder till required.

Fig. 96 shows the connections of the various

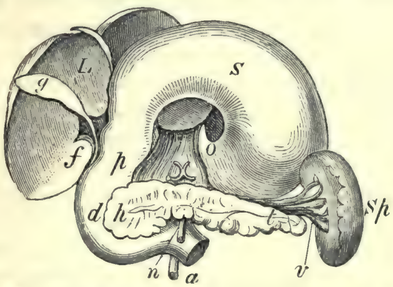


Fig. 96.—Relations of the Stomach to the Liver, Pancreas, and Spleen.[1]

parts spoken of, and the figure should be studied in the light of the above explanations.

The **Pancreas** is a much smaller gland than the liver, weighing not more than 2 or 3 ounces. It lies behind the stomach, and its large end or head lies in the curvature formed by the duodenum. Its position is well shown in Fig. 96, where the stomach is represented turned upwards to permit it being seen. In its structure it resembles the salivary glands (p. 137), its ducts terminating in recesses lined with large cells which prepare the juice of the gland. The main duct of the gland runs from one end of the organ to the other, collecting the materials from numerous smaller channels on the way. It finally issues from the gland to pierce the back wall of the small intestine in company with the common bile-duct, and thus is able to pour its secretion among the food which has passed down from the stomach.

The Digestive Process.

We have considered the character and structure of the digestive apparatus, the tract along which the food is conveyed and the various glands in connection with it; and we have seen that these glands pour various juices into the canal to mix with the food, namely, the saliva, gastric juice, bile, pancreatic juice, and intestinal juice. Let us now consider the changes undergone by the food as it passes along the digestive tract, and the part these juices and other agencies play in the change.

Mastication is the first part of the process to which the food is submitted. By this is meant the breaking down of the food by means of the teeth. In some animals, such as the tiger, the lower jaw is movable on the upper in one direction mainly, an upward and a downward movement that permits of tearing the food. In other animals, such as the cow, the movement is from side to side, the grinding teeth being specially employed. In man, however, owing to the shape of the joint between the lower and upper jaws, the lower is movable in many directions, so that a cutting or tearing and a grinding movement as well is permitted. While the food is being thus broken down it is moved about and mixed by movements of the tongue and cheeks, so that every part of it may come under the operation of the teeth. The advantage of this is obvious. The more completely the food is separated up into small portions the more easily will the digestive fluids reach every particle of it, and the more thorough and speedy will digestion be. The disadvantage, then, of "bolting the food" ought to be apparent. If the breaking down process is not accomplished in the mouth it must be performed by the stomach, and the stomach has no apparatus for such a purpose. Children in particular, who are very prone to swallow their food almost without chewing it, should be trained to take time to do this part of their eating thoroughly.

Insalivation. While chewing is going on the saliva is streaming into the mouth, and is being intimately mixed with the food, and to

[1] The stomach is represented turned up, *S* being on its under surface. *p* indicates the junction of stomach and duodenum (*d*) at the pylorus. *O* is placed at the junction of stomach and gullet. *L* is on the right portion of the liver, which is also turned up to show *g*, the gall-bladder. *f* is placed to the side of the common bile duct formed by ducts from the liver and gall-bladder. *h–t* is the pancreas, revealed by the turning up of the stomach. *Sp*, spleen. *v*, the part where blood-vessels are connected to the spleen. *n* and *a*, blood-vessels.

this the term insalivation is given. The **saliva** is a colourless fluid, without smell or taste. It contains in solution very few saline matters, only about 5 parts in 1000. Its principal element, besides water, is a substance called **ptyalin**, which is a ferment, and possesses the remarkable property of being able to convert starch into sugar. As much as 48 ounces of saliva may be poured into the mouth daily. Thus in the mouth, and while chewing is being performed, another process is going on which has for its purpose the conversion of starch, which cannot dissolve in water, and cannot pass through an animal membrane, into sugar, which can do both. Besides effecting this object saliva also moistens the food so as to enable it to be made up into a consistent mass fit for swallowing. Saliva aids also in speech by moistening the mouth.

Deglutition. The food having been thoroughly broken down and mixed with saliva is in a proper condition for deglutition or swallowing. The tongue gathers it up into a bolus or mass and forces it backwards through between the pillars of the fauces into the pharynx, by whose muscles it is grasped. Now, having reached the pharynx, the food, it is easy to see, might be forced in various directions by the contractions of the constricting muscles of the pharynx. Reference to Fig. 88, p. 136, will explain how this comes about. Thus it might be forced back again into the mouth. This is prevented by the contraction of the front pillars of the fauces and the forcing backwards of the tongue. The food might pass upwards and get through the openings of the nasal cavity behind. This is prevented by the back pillars of the fauces contracting and the soft palate being raised to bar the way. It might pass down into the windpipe, but this is also prevented by the box of the windpipe being quickly raised up under cover of the root of the tongue. The elevation of this part of the windpipe any one may feel by putting a finger on the front of the neck and then swallowing. At the same time as the windpipe is thus raised, its lid, the epiglottis (*ep*, Fig. 88), is lowered so as to cover the entrance. The food has thus only one pathway, namely, down the gullet. When it has been forced into this tube the walls contract in a wave-like fashion, and thus propel the food onwards to the stomach. The food does not then fall into the stomach from the mouth. It is carefully conducted thither. This is why a horse can drink though its mouth be below the level of its gullet, and why a man can drink standing on his head. Part of the movements that have been described are under the control of the will, part are involuntary. The forcing of the food backwards is voluntary; but as soon as it has entered the pharynx all the other movements will occur in due order whether we will it or not. They are accomplished by a reflex nervous action (p. 86).

Digestion in the stomach. As soon as the food reaches the stomach that organ becomes active. By the contractions of its muscular walls the food is moved about, and mixed with gastric juice poured out of the gastric glands as described on page 139. The action of the juice is aided by the heat of the parts. The gastric juice is acid owing to the presence of a small quantity of acid, usually hydrochloric acid. It contains besides a ferment called **pepsin**. It is owing to the presence of the acid and pepsin in the stomach that digestion is performed. The action of the juice is on albuminous substances. Now albuminous substances are not soluble in water nor can they pass through animal membranes, but by the action of the juice they become converted into what are called **peptones**, which are both soluble and capable of passing through membranes. The juice of the stomach has an action on fat to this small extent, that fat consists of a drop of oil in an albuminous sac, and by the juice this sac becomes dissolved, so that the oil is freed, but no further action on it is effected. Thus it is only on albuminous food stuffs that gastric juice acts. As a result of the action in the stomach the food becomes converted into a semi-fluid mass called **chyme**.

Digestion similar to that performed in the stomach can be artificially produced. An acid solution of pepsin is required. This is obtained in the following way. The stomach of a pig is taken, opened up, and very gently washed with a stream of water. The inner coat—the mucous membrane—is then stripped off, cut into very small pieces, placed in a bottle among glycerine and water containing a small amount of hydrochloric acid ($1\frac{1}{2}$ drachm to every 100 ounces). It is allowed to stand for several days. The glycerine and acid solution extract the pepsin from the glands of the stomach. If now some small pieces of boiled meat, boiled egg, fish, &c., be put into a glass vessel with some water, and if a small quantity of the glycerine extract of pepsin be added, and the whole kept at the temperature of the body—about 99° Fahr.—in a few hours the meat will have undergone diges-

tion. Pepsin wine may be made by adding sherry wine to the glycerine extract. The pepsin powder that may be obtained from chemists is prepared from the pig's or calf's stomach. Rennet, which is used for curdling milk, is a preparation of the calf's stomach, and owes its property to the pepsin it contains. Indeed, what happens to milk on the addition of rennet is precisely similar to what happens to milk passed into the stomach. Owing to the acid of the stomach and pepsin, aided by the heat of the parts, the milk is curdled, and separates into curd and whey. The curd contains the main albuminous constituent of the milk, **casein**, which the pepsin forthwith proceeds to attack. It is thus *seen that the curdling of milk in the stomach is a first and essential part of the process of digestion.* This it is desirable to note, because many mothers, after permitting a child to drink too much milk, are alarmed to see the child, after some time, vomit curdled milk. The vomiting does not alarm them, but the curd does. The explanation usually is that the stomach, being overloaded, rejects some of the milk in a curdled condition, because it has already come under the influence of the gastric juice.

Conditions of digestion in the stomach. The acid is as necessary to the process as the pepsin, for it has been shown in artificial digestion that pepsin alone cannot act upon albuminous food in a proper way. Hence if the gastric juice be too feebly acid, or if the acidity be destroyed by soda or other alkalies, for instance, digestion will be imperfect. But an excess of acid equally interferes with the process; thus what is called "acidity of the stomach" produces indigestion in this way. Excess of alcohol also impedes the process.

Overfulness of the stomach will impede the movement of the walls, and therefore the mixture with the juice, and so hinder digestion.

It has been seen (p. 139) how a due supply of blood is necessary for the formation of the digestive fluid. If the blood be occupied elsewhere, as it may be if active exercise be engaged in immediately after food, there may be insufficient for digestive purposes, and a delay in the process results. The secretion of the juice is also undoubtedly under the control of the nervous system. For this reason, no doubt, active brain work immediately after food, either by diverting the nervous activity or by diverting the blood supply, the brain by its activity making great demands on both, may produce indigestion. Gentle exercise, therefore, and repose of mind, are conditions favourable for digestion.

It may be that owing to ill health the blood supply may be poor, and the nervous tone indifferent, so that indigestion may be only one symptom of general ill health.

The stomach, like all other organs of the body, should have periods of rest following its periods of activity, and these periods should follow one another regularly.

Time required for digestion. Various kinds of food require varying times for digestion. This was proved by a remarkable set of experiments performed, in 1838, on a man named Alexis St. Martin, by Dr. Beaumont. St. Martin had an opening made in the front wall of the stomach by a gunshot wound. Even after complete healing of the wound a small opening was left through which the mucous membrane of the stomach could be seen, and through which substances could be introduced into the stomach or withdrawn from it. It was found that rice and tripe were digested most speedily, the time required being one hour. Eggs, salmon, trout, apples, and venison occupied an hour and a half, tapioca, barley, milk, liver, and fish, two hours, turkey, lamb, and pork, two hours and a half, beef, mutton, and fowls, about three and a half hours, and veal even longer.

Absorption by the stomach. We have seen that the mucous membrane of the stomach is richly supplied with blood-vessels. The blood flowing in them is separated from the semi-liquid food only by a thin animal partition. There is, therefore, no impediment to an interchange taking place between the blood and the food. What the nature of that change will be we have already learned (p. 135). Water, along with any substances in the food that have become dissolved, will pass through the partition and gain access to the current of blood. Thus a considerable quantity of salts in solution, of starch that has become converted into sugar, of albumen converted into peptone, will, without further delay, gain entrance to the blood. Starch that has escaped the action of saliva, albumen that has escaped the action of gastric juice, and fats, will remain in the food, and will be passed on into the small intestine, where the digestive process is continued by other juices.

Digestion in the small intestine. The chyme does not pass all at once from the stomach into the small intestine. It has been found that food already acted on by the gastric

juice, if allowed to remain in the stomach, impedes the continuation of the process. The food seems to be digested in the stomach in detachments, and as soon as a portion has become sufficiently digested the pyloric valve, that we have noted (p. 130) as guarding the communication between stomach and small intestine, the pyloric valve opens, permits that portion to escape into the small intestine, then closes, and opens again as soon as a further quantity of food is ready. The stimulus of the food passing over the openings of the bile and pancreatic ducts causes a discharge of bile and pancreatic juice, which proceed to mix with the food and act upon it.

The **pancreatic juice** is alkaline, and contains several ferments: one of them, like saliva, converts starch into sugar; another, like the gastric juice, converts albuminates into peptones, and may even proceed further and split up peptones into other bodies; and a third acts upon fats, making them into an emulsion or milk-like mixture, which is to some extent capable of passing through animal membranes, while fat cannot. Pancreatic juice seems also to split fats up into a fatty acid and glycerine, both of which can be absorbed. Thus starch which has escaped the saliva, and albumen which has escaped the gastric juice, are acted on by the pancreatic juice, and prepared for admission to the blood, the fat unacted on by either of the former juices not escaping the third.

The **bile** is also alkaline, and of a reddish yellow colour. When it has been vomited it is distinctly yellow, because of the action on it of the gastric juice. As much as 2½ pounds weight of it may be poured into the small intestine of man in 24 hours. It contains a considerable quantity of colouring matter; and its chief ingredients are two salts of soda, the taurocholate and glycocholate of soda. Owing to the presence of these two salts the bile is capable of forming a soap with fat, and thus largely aids the pancreatic juice in enabling oil to become fit for absorption.

Owing to the action of these four juices, aided by the intestinal juice secreted by the tubular glands of the intestine (p. 140), the chyme becomes transformed into **chyle**. The chief distinctions between chyme and chyle are that the former is acid, the latter alkaline. In the former the oil floats in large globules; in the latter it is evenly diffused throughout the liquid as in an emulsion, and this gives to chyle its milky appearance. The chyle is propelled along the intestine by spiral (peristaltic) contractions of its muscular walls. A function of the bile not yet mentioned is to stimulate these movements, and at the same time to prevent putrefaction of the contents of the intestine. This explains how, when, in diseased conditions, bile is prevented passing into the small intestines, constipation results, and when the stools are passed they are badly smelling, and very light in colour, owing to want of the bile-colouring matter.

The special purpose of digestion in the small intestine is then the digestion of fat, while, at the same time, all the other food stuffs are acted on.

Absorption by the small intestine. The food is propelled along the small intestine, as we have seen, by movements of the muscular walls. The length of the tube is considerable—at least 20 feet—and it is richly supplied with blood along its whole course. Hence what we have observed to occur in the stomach will also occur here, water containing in solution salts, starch converted into sugar, and albumen converted into peptone, will be taken up directly into the blood. In addition some amount of changed fat will enter the circulation. We have noticed, however, special structures in the small intestine, namely, the villous projections (p. 139) containing a loop of blood-vessels, and another vessel—the lacteal. These are specially for the absorption of fat. They dip like fingers into the chyle, and the minute particles of oil pass through their cellular covering and gain entrance to the lacteal. The folds of the small intestine permit a large number of the villi to be present, and a large surface for fat absorption is therefore provided. Thus in the small intestine the nourishing portions of the food are withdrawn in two ways, (1) by blood-vessels and (2) by lacteals. The material that enters the lacteals joins the blood current later. It is conveyed by lacteal vessels through the mesentery to reach glands where it undergoes certain changes, and finally reaches a vessel—the **thoracic duct**—which passes up the front of the backbone to reach the root of the neck, where it opens at the junction of the great veins of the left side of the head and left arm. We see, then, that all the nourishing material obtained from the food sooner or later enters the blood.

Digestion in the large intestine does not occur to any great extent. The food enters this portion of the digestive tract through the ileo-cæcal valve situated in the left groin (p. 139). Although the great intestine is much shorter than the small, the remains of the food travel

through it slowly, the pouches into which the walls are thrown preventing their speedy passage. Time is thus given for fluid matters to be abstracted by the blood-vessels of the mucous membrane. The remains of the food become consequently less fluid, and they acquire their characteristic odour. They are called **fæces**, and consist of undigested or indigestible materials, and of substances derived from the bowel itself, with a part of the bile from the liver. Propelled onwards by the contractions of the muscular walls, they at last reach the rectum, where their accumulation gives rise to the sensation that ends in the voluntary effort by which they are expelled from the body.

The **nervous relations** of digestion are not thoroughly understood. That digestion is controlled by the nervous system is quite certain. The salivary glands, for instance, have their activity regulated by nerves, some fibres of which find their way to the very cells of the glands. Such direct relationship is not known in the case of the other glands of the digestive tube. This we do know, however, that the formation of the digestive juices is directly dependent upon the quantity of blood supplied to the glands, and that the blood supply is controlled by nervous influence in a way that is explained in treating of the circulation of the blood. Conditions of the nervous system will, therefore, directly or indirectly influence digestion.

Hunger and Thirst.

Hunger and Thirst are two sensations connected with the alimentary function. **Hunger** is the call of the body for solid nourishment, and **thirst** the call for water.

Hunger is a sensation referred to the stomach, and, if not appeased, to the intestine later, and is relieved by the introduction into the stomach of a sufficient quantity of nourishing food. It may also be relieved, for a time, by passing into the stomach substances that are not nourishing. It does not seem, however, to be due to mere emptiness of the stomach, for, undoubtedly, after a full meal the stomach is empty for some time before there returns the **appetite** for more food, which is just a modified sense of hunger; besides, alcohol, tobacco, opium, and other narcotics restrain the sensation for some time. The nervous system influences the sensation in a remarkable way. We all know how persons, engrossed with work, may want food for many hours without experiencing any of the sensations of appetite or hunger, and how some impression on the nervous system, such as that caused by the sudden receipt of bad news, anxiety, &c., may abolish the sensation, or may delay its production for a long time. The desire for food may also be relieved by the introduction of nourishing material into the bowel, while hunger may continue even when the stomach is filled with food, if, owing to disease, the food is prevented passing onwards, and the process of absorption is interfered with. The sensation of hunger may become excessive even when food in sufficient quantity is regularly supplied. This is really a diseased condition, to which the term **bulimia** (p. 181) is applied. For the opposite condition, that of loss of appetite and distaste for food, the term **anorexia** is used. It accompanies most digestive disorders, fevers, &c.

Thirst is a sensation referred to the throat, and, while indicating a deficiency of liquids in the system, it may be produced by the action of drugs like opium, and specially belladonna, or its active principle atropia. Highly salted and spiced substances, by their action on the mucous membrane of the throat and other parts of the alimentary canal, also occasion the desire for water. Thirst is more clearly a general condition of the system than hunger, for it may be rapidly relieved by the passage of water into the blood from injections of water thrown into the bowel, or by the direct injection of water into the veins. The immersion of the body in water relieves for a time, and even the covering of the body with garments soaking with water.

If hunger and thirst are not satisfied, **starvation** arises.

The Functions of the Liver.

The structure of the liver has been described on pages 141 and 142, and its function in digestion has been referred to on p. 145. But the part the liver plays in the digestive process is only one of its duties, and perhaps not the most important. The consideration of its other business is not properly included in a description of digestion. It is advisable, nevertheless, to have a complete view of all the functions of the liver in order to estimate the great importance of that organ in the bodily economy.

The **Functions of the Liver** are indeed not single, but several. As we have seen, it secretes the bile, and therefore ranks (1) as a *secretory organ*, an organ, that is, which elaborates a fluid for use in the body. But the bile is not wholly

a digestive fluid. It aids in the digestive process, but it also contains ingredients which are separated from the blood, for the purpose of being *cast out* of the body, because their remaining in the blood would impair its quality. In respect of this the liver ranks (2) as an *excretory organ*, an organ, that is, which separates material of no use to the body, and which is destined to be expelled as waste matter. This will be more easily understood by noting, in detail, the constituents of bile. It contains roughly 86 per cent water, and 14 per cent solid matter. The solid matter consists (*a*) of the bile salts, the glycocholate and taurocholate of soda, (*b*) of colouring matters, (*c*) of fats, (*d*) of inorganic salts, chiefly chloride of sodium (common salt), with a smaller quantity of phosphates, and traces of iron and manganese, and (*e*) of a crystalline substance called cholesterin, a substance found in the brain, and seemingly brought to the liver by the blood. There is also in bile a considerable quantity of mucus, obtained from the bile-ducts and gall-bladder. These substances are in the following proportions :—

Water, ...		85·92	in 100 parts of bile.
Solids—			
Bile salts, ...	9·14	14·08	,, ,,
Colouring matter and mucus, ...	2·98		
Fats, ...	·92		
Inorganic salts,	·78		
Cholesterin, ...	·26		

Of these the chief are the bile salts, and the colouring matters—the bile pigments. They do not exist already formed in the blood, as do the salts and the cholesterin, and must be formed from materials in the blood by the activity of the liver cells. Now it is the bile salts that act on fats in the alimentary canal and aid in their emulsion and absorption. They appear to be themselves split up into other substances and absorbed, for they are not found in the fæces. The colouring matter of bile is derived from the colouring matter of the blood. The pigment of human and carnivorous animals is *bilirubin*, of a golden red colour. In herbivorous animals it is *biliverdin*, a green pigment. The red pigment is readily converted by oxidation processes into the green. These pigments are cast out in the fæces. Their presence *in the blood* gives rise to the yellowness in cases of jaundice.

(3) The third function of the liver is very different from those already considered. A French physiologist, Claude Bernard, was the first to point out that the liver formed a substance, like starch, which was readily converted into sugar. He called it **glycogen**; it is also called **animal starch.** If an infusion of pieces of the liver of any animal be made, it will be found to be rich in sugar (grape sugar, or *glucose*). But if the liver of an animal, just killed, be rapidly removed from the body and thrown into boiling water, an infusion does not contain sugar. It is opalescent or even milky. By adding alcohol to it a white precipitate of glycogen falls. If to the opalescent infusion saliva be added (which converts starch into sugar, p. 143), the infusion clears up, and sugar may now be detected in it—the glycogen has been transformed into sugar. Moreover, if water be injected into the portal vein (p. 140) of a liver, removed from an animal, and the injection continued till the water issues from the hepatic vein, sugar will be found in abundance in the water. If the injection be continued till the liver is well washed out, the washings will at last contain no sugar. If the liver be now left for a few hours, and then the injection repeated, sugar will again be found. It appears from such experiments, and many others, that the liver forms glycogen, which is stored up in the liver cells, and that it also contains a ferment capable of transforming the glycogen into sugar. The liver forms its glycogen chiefly from starch and sugar, taken as food, and passing as sugar to the liver by the portal vein. So far as can be learned, the fate of glycogen is to be gradually retransformed into sugar and sent to the tissues, as their needs demand, to supply them with material for their energy and heat. The liver thus has a great purpose to serve in the nutrition of the body. Its *glycogenic function*, as it is called, throws light on the disease *diabetes*, in which sugar appears in the urine.

(4) Fats may be formed or arrested by the liver-cells. Liver-cells usually exhibit bright dots of oil-globules (p. 141), which may so increase in number that the cell appears to contain nothing but fat. The liver of domestic animals, especially of those kept in confinement, tends to become very fatty. The luxury known as *patê de foie gras* is made of the fatty liver of Strasburg geese. These animals are kept in close confinement and stuffed with rich food, so that the fatty degeneration speedily occurs.

Thus, then, the liver aids in the process of digestion by secreting the bile; it also separates certain waste substance from the blood, and it stores up in its cells substances which are destined to take part in the general nourishment of the body.

Section VI.—THE DIGESTIVE SYSTEM.

B.—ITS DISEASES AND INJURIES.

Diseases of the Mouth, Lip, Tongue, and Teeth:

Inflammation of the Mouth—Ulcers—Thrush (Sprue)—Tumours (Ranulæ), &c.;

Harelip and Cleft Palate;

Ulcers of the Lips, Cracks, Growths, and Cancer of the Lip;

Inflammation of the Tongue—Ptyalism—Ulcers, Cancer, Tumours, and Injuries of the Tongue;

Inflammation of the Gums—Gumboil;

Toothache—Stopping of Decayed Teeth—Bleeding after Extraction of Teeth—Tartar of the Teeth—Care of the Teeth.

Inflammation of the Salivary Glands (Mumps, Branks, Parotitis).

Diseases of the Fauces (throat) and Gullet:

Catarrh (Cold in the Head);

Inflammation of Tonsils (Tonsillitis, Quinsy, Sore-throat)—Chronic Enlargement of Tonsils—Enlarged Uvula—Relaxed Throat;

Obstruction of the Gullet (Stricture)—Difficulty of Swallowing (*Dysphagia*).

Diseases of the Stomach and Bowels:

Inflammation of the Stomach (Gastritis) *acute* and *chronic*—Acute Gastric Catarrh;

Ulceration and Cancer of the Stomach;

Bleeding from the Stomach (Haematemesis);

Dilatation of the Stomach;

Inflammation of the Bowels (Enteritis)—Typhlitis;

Ulceration of the Bowels;

Obstruction of the Bowels—Intussusception—Foreign Bodies;

Consumption of the Bowels (Abdominal Phthisis, Tabes Mesenterica);

Bleeding from the Bowels (Melaena);

Cancer of the Bowels;

Intestinal Worms—Tapeworms (Tœnia Solium, Tœnia Mediocanellata, Bothriocephalus Latus, Tœnia Echinococcus (Hydatids))—Symptoms and Treatment of Tapeworm—The Prevention of Tapeworm; *Round Worms (Common Round Worm, Ascaris Lumbricoides), Thread Worm (Oxyuris Vermicularis), Whip Worm (Tricocephalus Dispar), Trichina Spiralis (Trichinosis)*; Symptoms and Treatment of Round Worms;

Indigestion (Dyspepsia), including Loss of Appetite (*Anorexia*), Excess of Appetite (*Bulimia*), Sickness (*Nausea*) and Vomiting, Flatulence, Pain (*Cramp*) in the Stomach, Water-brash (*Pyrosis*), Hiccough, and Colic;

Constipation and Diarrhœa;

Dysentery and Cholera.

Diseases of the Abdominal Cavity and Walls:

Inflammation (Peritonitis), Dropsy (Ascites), Rupture (Hernia).

Diseases of the Rectum and Anus:

Fissures and Ulcers of the Anus and Rectum, &c.; *Piles; Prolapse* (falling down); *Fistula;*

Itching of the Anus (Pruritus); Foreign Bodies and Tumours.

Diseases of the Liver:

Congestion, Inflammation, and *Abscess of the Liver; Cirrhosis* or *Thickening* of the Liver (Hob-nailed, or Drunkard's Liver);

Inflammation and Obstruction of Bile Ducts;

Biliousness, Jaundice (Icterus), Absence of Bile (Acholia), and *Gall Stones;*

Degenerations of the Liver—Fatty and Waxy Degeneration;

Tumours of the Liver.

Diseases of the Pancreas:

Inflammation, &c.

Diseases of the digestive system are very numerous and important. In some respects, indeed, they are the most important class of diseases that fall to be considered in a work of this kind. In a sense the digestive organs are more open to the attack of disease than any others. In normal circumstances a person's lungs, for example, are well guarded; his heart is beyond his control, and cannot be directly affected by him; but his stomach is daily at his mercy, is daily the victim of his whim, his taste, or his passion, has no fixed periods of work and repose, like lungs and heart, but is at one time overburdened, and at another per-

haps in a state of inactivity for many hours. Everyone knows the effects of overwork on the body, or of overwork on a particular part of the body—an arm, for instance. We all know what is the feeling of a tired arm, or a wearied set of muscles, and we all interpret the feeling properly enough, and have usually sufficient sense to give the jaded arm or muscles rest in order to recovery. But we do not speak of a wearied stomach; and multitudes of people do not understand what that sensation is, not because they never experience it, but because they never rightly interpret it. Yet a stomach tired with overwork, and giving rise to feelings which are its loud calls for rest, is probably a more common sensation, at least as common a sensation, as a fatigued muscle. Its calls, however, are not properly understood; and instead of repose, it more often receives excitement. A tired stomach is as unfit for the full discharge of its proper work as a wearied arm is unfit for its labour. Its performance will be incomplete. The very first part of the process of preparing nourishment for all the organs of the body is improperly carried out, and the effects of that first failure it is difficult fully to appreciate. If every organ and tissue of the body seek their nourishment from the blood, and if the quality and quantity of the blood are mainly dependent upon material obtained from the food, which has undergone a process of preparation in the stomach and intestine, it is evident how the fitness of the blood to nourish the body necessitates the integrity of the digestive process.

Again, the digestive system is one of the main gateways of disease. We all know how speedily poisons may destroy life. But most poisons are harmless when applied to the outside of the body. It is only after they gain entrance to the body, chiefly after they gain access to the current of blood and are able to attack directly one organ or another, that their effects can be obtained. Their chief way of gaining entrance is by the stomach, though it is not their only way, as we shall see when we come to consider poisons. Now this is true not only of those things that everyone regards as poisons. The old proverb, "One man's meat is another man's poison," is a very true one, and points to the fact that what one man may eat and drink with satisfaction and benefit another man may not eat or drink without serious disturbance. This may happen, not because of the nature of the substance, but because of the peculiarity of the individual. There is, therefore, a perpetual possibility that a person may take in his food or his drink something that is, from its very nature, injurious to his system; and also that he may introduce something into his stomach which is not of itself hurtful, but which, owing to his peculiarity, may become the cause of disorder. Thus the digestive system is a gateway of disease that stands continually open.

It is advisable to recall here the distinction that has been explained between organic and functional disease. An organ may have some defect of structure which makes it organically diseased, but the performance of its duties may not be affected in proportion to the extent of the organic disease; while an organ may not discharge its business properly though there be no departure from the normal in its structure. In the latter case it is affected with a functional disease. So we shall see, as we go along, that some diseases of the digestive system particularly affect structure—inflammation, ulceration, cancer, &c.; while it may be the seat of severe functional disease—indigestion, for example—though its structure is not sensibly affected.

It is strongly urged that anyone consulting this section, specially in reference to such disorders as are classed under the heading of indigestion, should carefully read the description of the digestive process given in the preceding pages. Disorders of digestion cannot be understood without a previous acquaintance with the physiology of the digestive process.

DISEASES OF THE LIP, MOUTH, TEETH, &c.

Inflammation of the Mouth, accompanied by the formation of ulcers on the tongue and inside of the cheek, and decay of the gums, is specially a disease of children. (Refer to DISEASES OF CHILDREN.)

Thrush or Aphthæ (*Sprue*), in which small white patches are formed over the tongue and lining membrane of the mouth, is also specially a disease of childhood.

For **Hare-lip** and **Cleft-palate** see also DISEASES OF CHILDREN.

Ulcers of the Lips occasionally form on the mucous membrane lining the inside of the lips. The ulcers are of a small circular or oval shape, of an ashen-grey colour, and depressed beneath the surface. They are painful, particularly when chewing is performed. They may be caused by the irritation of a bad tooth, and are frequently the accompaniment of digestive disorders.

Their **treatment** consists in removing any

cause that may exist in the form of bad teeth, and in the use of simple opening medicine, such as seidlitz-powder, citrated magnesia, &c. The pain is rapidly relieved and the ulcer healed by applying with the finger, or a camel-hair pencil, some of the tincture of myrrh and borax, or a solution of chlorate of potash (15 grains to the ounce of water) with a small quantity of added glycerine. A solution of the same strength of borax and glycerine, or borax and honey, is also useful.

Cracks and Fissures of the Lips should be treated with glycerine or vaseline, the lip being kept constantly soft and moist.

A **Warty Growth,** quite white and mushroom-like, is often seen on the lips. It should be touched with glacial acetic acid once or twice daily, and will soon disappear. Care must be taken not to permit the acid to touch the rest of the lip. It is best applied by a small piece of wood—the end of a match, for example—which is moistened with the acid.

Cancer of the Lip.—The lower lip is a favourite seat of a particular form of cancer known as epithelioma, or skin cancer. It is so called because it consists of a tumour due to an enormous increase of cells similar to the epithelial that form the outermost layer of the skin. The disease is commoner in men than in women, and specially in men of the labouring classes. It seems to be caused often by long-continued irritation. Thus it is frequently found that a man with cancer of the lip is in the habit of smoking a short juicy clay pipe, and that the tumour is on that side at which the pipe is held. But other constant irritations seem capable of causing it.

Symptoms.—It begins sometimes as a crack or fissure, which is annoying because of its refusal to heal, sometimes as a sort of wart, at other times as a hardening and thickening in the skin. In this form it may continue for a long time. Sooner or later the skin breaks and an ulcer is formed. The ulcer has a hard base and edge, and gives out a thin, foul discharge. If not removed it is bound to spread, to grow deeper and broader, and to affect the glands and other parts.

The **treatment** is without doubt removal by the knife, and the sooner it is removed the better. If once the glands have become affected the case is serious. If, therefore, anyone has a deep hard ulcer of the lip, which stubbornly refuses to heal under ordinary remedies, and especially if it is on that part where the mucous membrane of the lip joins the skin, a regular surgeon should, without delay, be consulted.

Inflammation of the Tongue accompanies the affection called **salivation or ptyalism,** in which the chief feature is a continuous flow of badly-smelling saliva, which constantly dribbles from the mouth. The salivary glands are swollen and painful, and the tongue, gums, and other parts of the mouth share in the inflammation and swelling. The smell from the mouth is very foul. The excessive salivation is frequently due to mercury, not necessarily to its excessive use, for some people are peculiarly liable to its influence, and with them even a single grain of calomel may produce the effects. In such a case the treatment consists in the use of mouth-washes of chlorate of potash, or chlorinated soda (see PRESCRIPTIONS—GARGLES, &c.), in the use of opening medicine, and 3-grain doses of iodide of potassium given in water thrice daily.

Inflammation of the tongue with great swelling, pain, and inability to speak or swallow, may, however, occur alone. It is to be treated with brisk doses of opening medicine of ordinary salts, or seidlitz salts. Gargles similar to those prescribed above are also to be used. Large hot applications under the chin will help to relieve the pain and the swelling, and leeches may be necessary. An abscess may be formed, which will of course require opening. Sometimes such inflammation will cause the tongue to attain a size greater than the mouth can contain, so that it is protruded outwards.

Ulcers of the tongue are frequent, and are commonest at the sides from friction with a decayed tooth. The tooth should be removed, and the treatment, advised for ulcers of the lip, adopted.

Cracked Tongue exhibits a series of irregular furrows, often of some depth, running over the surface of the tongue. They are very painful, and interfere with speaking and eating.

Any digestive disorder which may be the cause should be properly treated, and the borax-and-glycerine wash mentioned above used freely.

Cancer may have its seat in the tongue. It is usually of a sort akin to that of the lip, presents similar characters, and demands similar treatment—removal by operation.

Tumour under the Tongue.—**Ranula** is the name applied to a form of tumour under the tongue, which consists of a sac filled with a gelatinous sort of fluid. The tumour may be so large as to affect speech and even push the

tongue upwards or to the side. It is associated with the duct of the gland under the tongue, and is supposed to be due, sometimes, to the blocking of that canal. A surgeon should be consulted for its removal.

Warty Growths are also formed on the tongue. The acetic acid, as used for similar growths on the lips, may be tried.

Injury to the Tongue is frequently caused by accidental bites. The teeth may even be driven deeply into the tongue by a fall. It is best to leave the tongue alone in such a case, and to permit nature to heal the wound. Bleeding may be controlled by pressure over the part.

Inflammation of the Gums is common in children during the period of teething. It is considered in the section on DISEASES OF CHILDREN. Simple inflammation may occur in grown-up people. The part of the gum affected is dark red, congested, and very tender. A brisk purge and hot application to the part will relieve; but, often, nothing is equal to free lancing, which permits the excess of blood to escape, and thus immediately gives relief. A commoner thing in elderly people is that condition in which the gums become spongy, soft, constantly painful, and liable to bleed at the slightest touch. They separate from the teeth, which become loose in consequence.

The **treatment** should be directed as much to the general bodily condition as to the condition of the gums. Sluggish action of the bowels and liver will maintain the bad state of the mouth. Free use of purgative medicines should, therefore, be made to unload the digestive organs, and astringent washes and gargles used for the mouth, those of chlorate of potash, borax, or tannic acid being best, while a tooth-brush should be used daily with camphorated tooth-powder, the gums being well rubbed.

Gum-boil is usually due to the irritation of a decayed tooth. Beginning in the socket of the tooth it works its way outwards. The more deep-seated it is and the greater difficulty it has in coming to the surface, the more intense will be the pain. Usually it is evident from the swelling of the gum that a gum-boil is being produced. Sometimes when it is deep seated, at the end of the fang of the tooth, there is no apparent swelling. In such a case, that suppuration is going on at the end of the tooth is ascertained by firmly pressing the tooth down into its socket. This procedure will give rise to severe pain if an abscess be forming at the root of the tooth, and will thus indicate the seat of mischief.

The **treatment** consists in the use of hot applications, in the removal of the decayed tooth, and in letting out the matter where it comes to the surface. If the tooth that is the source of irritation be not removed or otherwise properly treated, the gum-boil is liable to recur again and again.

Toothache is due to decay of the substance of a tooth—**dental caries**, as it is called. It has been pointed out (p. 137) that the crown of a tooth consists of a cap of very hard substance called enamel, covering the dentine, which forms the main bulk of the tooth, and is not so hard as the enamel. Now the enamel is a very resisting substance, though it is brittle, and so long as it is perfect the tooth is not liable to the carious disease. Sometimes, however, the enamel is imperfect and the dentine becomes exposed, and the process of softening and breaking down begins. The dentine may be attacked through so small an opening in the enamel that the tooth appears to be perfectly sound, while it may be completely decaying within. The decay seems to be due, in the first instance, to a chemical process, whereby the salts of the enamel and dentine are removed by acids produced in the mouth. The acids are not produced by the glands of the mouth, nor are they normal constituents of any of the fluids of the mouth. They are produced by the decomposition of particles of food that lurk in recesses about the teeth. Certain parts of the teeth more easily retain portions of food, which may in time, owing to decomposition, obtain the power of attacking them; notably in the furrows between the cusps or points on the surface of the large grinding teeth will food remain, as well as round the neck, and between the teeth. Again, some parts of the teeth are more exposed to attack than others, any parts, for example, from which the enamel has been worn away. Teeth which are too much crowded, therefore, will have more surfaces than usual pressed upon and rubbed, and so overcrowding is a frequent cause of bad teeth. It ought, also, to be remembered that the teeth share in general states of the body, and that a long period of ill-health may, indeed quite commonly does, very materially affect their resisting power and make them easy victims to decay. A person often bears the marks of a long illness in irregularities of the teeth. When the dentine has become exposed it begins to

soften, to become more or less discoloured, and to break down. As the affection passes inwards the pulp is reached, the intimation of which is that toothache begins. At first it may be that the tooth is affected only now and again when hot or cold things are taken into the mouth. The pulp contains blood-vessels and fine filaments of nerves, and, when the irritation reaches it, inflammation will readily arise, of which sensitiveness and aching are the signs. Suppuration of the pulp may arise, and, if the matter cannot escape above, it forces its way down the fang, at the end of which, in the socket of the tooth, the matter collects, forming a gum-boil. The inflammation and swelling also loosen the tooth, and raise it to some extent in its socket.

The **treatment** of toothache, short of extraction of the tooth, is seldom very satisfactory if the pulp has actually been attacked. One of the best applications, however, is carbolic acid. But it is difficult for anyone, not accustomed, to apply it properly, and it is liable to be so clumsily employed as to burn the mouth and tongue very severely. A small camel-hair pencil should be used, the hairs being cut rather short. It is moistened with the acid, care being taken that there is not enough on the brush to run, and the cavity of the tooth is to be well cleaned out by pushing the brush well into it and turning it about. The brush is to be removed, cleaned, and reapplied with some fresh acid, the person being permitted to wash the mouth with warm water between each application, to remove excess of acid. When the pain has been soothed, a small piece of cotton, moistened with carbolic acid, is to be pushed well down into the tooth, and it may be covered over with a piece of cotton soaked in a solution of gum mastic or benzoin. Creasote may be used in the same way. If a tooth be simply sensitive from exposure of the dentine, a mouth wash of two teaspoonfuls of bicarbonate of soda to a glass of water is recommended to be used several times a day to allay the pain.

Neuralgia is often mistaken for toothache. The main distinction is that neuralgia comes and goes, and specially that it very often returns at the same hour each day. Pregnant women are specially liable to this form of pain in the teeth. Teeth are often extracted in the hope of relieving pain, when it is neuralgia that is the affection and not toothache; and the extraction gives, at best, only temporary relief. Yet many people are reduced to such desperation by the constantly recurring pain that they will sacrifice one tooth after another, and often several at once. Neuralgic toothache is best treated by the person taking some ordinary opening medicine to begin with, and then pursuing for some time a system of tonic treatment with quinine and iron, or the phosphorus pill recommended on p. 113, and at the times of recurrence of the pain the quinine and salicylate powders recommended on the same page for neuralgic headache.

Stopping Decayed Teeth.—Much can now be done in the way of arresting the decay of teeth, and in repairing those already decayed. This is effected by scraping away the decayed and decaying parts of the tooth and filling up the cavity with gutta-percha or some kind of cement, or with gold or an amalgam. The kind of filling of which gutta-percha may be taken as an example is valuable, because it is not a conductor of heat. A tooth, formerly sensitive to hot or cold liquids taken into the mouth, will be protected by such a filling. On the other hand, a metallic filling, which readily conducts heat, would not render such a tooth less, but rather more, sensitive. The want of hardness of gutta-percha is its disadvantage, and the metallic substance is in this respect superior to it. So that the nature of the material with which a tooth should be stopped is largely dependent upon the tooth itself.

The best time for stopping teeth is before the pulp has been in any way attacked. In fact, the sooner any decay, present in a tooth, is discovered the better, and the sooner, after the discovery, steps are taken to arrest the decay, the more likely is a successful result attainable. For if the tooth be attended to early, a competent dentist may restore it to an almost perfectly satisfactory condition. There is, therefore, a very sufficient reason why those who can afford it should consult a dentist periodically to have their teeth inspected and, if need be, repaired. It should always be remembered that it is far preferable to have the natural teeth stopped, if possible, than to have artificial teeth, which are a frequent source of annoyance.

Anyone who wears plates of artificial teeth should always remove them at night, and should never go to sleep with them in the mouth; they are liable to slip off and pass back into the throat.

Bleeding after Extraction of teeth is sometimes troublesome, and even dangerous. The cavity left by the removal of the tooth should be well cleaned out. This may be done by means of a camel-hair pencil moistened with tincture of steel, which tends to produce con-

traction of the blood-vessels. A small piece of cotton steeped in the tincture is then pushed hard down into the bottom of the cavity; and one small piece of cotton after another is packed tightly in after it, till the cavity is filled up to the level of the top of the gum. A little pad of lint may then be placed on the top in such a way that the opposing teeth will press it firmly into the hollow when the mouth is shut. If the bleeding is not so severe as to require all this, cleaning out the cavity and touching it with tincture of steel, and then the sucking of ice for a short time, may arrest it.

Tartar, or salivary cálculus, is a deposit of earthy material on the teeth at the margins of the gums. The deposit is separated from the saliva, and is mixed with remains of food. It is found in greatest abundance on the front teeth of the lower jaw and the grinding-teeth of the upper jaw, because they are nearest the openings of the ducts from the salivary glands. It is an irritating substance, produces congestion and softening of the gums, which may lead to ulceration, separation of the gums from the teeth, and loosening of the latter in their sockets. If tartar has accumulated, it should be removed by a sharp instrument if necessary; but if proper care is taken of the teeth it will not be permitted to accumulate, and its evils will thus be avoided.

The Care of the Teeth and Mouth.—It has been seen that the common cause of decaying teeth and toothache is the product of particles of food permitted to remain and decompose in the recesses of the teeth. The best preventive of toothache is, therefore, cleanliness. The teeth ought to be brushed regularly once each day with a tooth-brush and tooth-powder. One of the best of powders is the camphorated chalk, to be obtained from any chemist. It ought not to contain any gritty material that could scratch the tooth and injure the enamel, and should be very fine and soft. For the same reason the brush should be soft, and the hairs not too closely set. The habit of using a tooth-brush ought to be begun early, and regularly persisted in. To remove food from between the teeth after meals a *quill* toothpick should be employed, and never a pin or other similar instrument, which is likely to injure the enamel. For the benefit of the gums and other parts of the mouth, a mouth-wash ought also to be constantly in use. One of the best is made by taking ¼ ounce of pure carbolic acid, the same quantity of the compound tincture of myrrh and borax, 1 ounce of glycerine, and 3 ounces of water. This is to be well mixed and kept in a bottle. When required, a small quantity is diluted with two or three times its bulk of water, with which the mouth is well cleansed and the throat gurgled. Among other things this wash is very useful for removing the bad smell of the breath, whether it arises from bad teeth, spongy ulcerated gums, or from smoking, &c.

Inflammation of the Salivary Glands (*Parotitis*, *Mumps*, (Scotch) *Branks*).—The salivary glands, and especially the parotid gland which lies in front of the ear (p. 137), are liable to an inflammatory affection, which, in this country, is popularly called the mumps.

The **symptoms** of the disease are that the gland swells, becomes hot, red, and painful. The swelling extends down towards the jaw and round the neck, so that the face becomes disfigured owing to its increased breadth by the swelling. One side is generally affected after the other. The swelling causes some pain, and difficulty in chewing and swallowing. Accompanying the disease are fever, white tongue, and headache, and perhaps pains in the limbs. The swelling goes on increasing for three or four days. In about a week, at the most, it begins to subside, and the tenderness to diminish, until, usually at the end of ten days or a fortnight, it has almost if not quite disappeared. A remarkable thing connected with the disease is that in the female it is often accompanied by swelling of the breast, and in the male of the testicle, which, besides swelling, become painful, and continue so for a few days.

The disease occurs epidemically, and is very infectious. It almost never happens that the same person is attacked twice. After the person has become infected, the disease takes nearly three weeks to show itself. It is specially a disease of childhood; and if it appears in a school or a family, several are liable to be attacked, either together or one after the other.

The **treatment** is very simple. The child is to be confined to one room and kept quiet. Gentle opening medicine—castor-oil, syrup of senna, or such simple medicine should be given at the outset. Hot applications to the inflamed glands are very soothing, hot cloths, bags of warm bran, or ordinary poultices. Light food only is to be allowed—milk, bread and milk, &c. Chewing is avoided by the use of such food, and the pain consequently lessened. If the breast swells, hot applications must be used,

and the same to the testicle, combined with a suspensory bandage to support the part.

This inflammation of the salivary glands must be distinguished from inflammations of lymphatic glands of the neck, which occur in scrofulous children and go on to the formation of matter. For consideration of such affections, refer to Section VII. on The Glandular System.

DISEASES OF THE FAUCES (THROAT) AND GULLET.

Catarrh is the proper medical term for the disease commonly called "cold," or "cold in the head." It is sometimes, though improperly, called **influenza**, for true influenza is an epidemic disease. **Weed** is the term applied to catarrh by the people. Its cause is exposure to cold, either by sitting in a draught, by too rapid cooling down after some severe exertion producing profuse perspiration, or by a wetting, and in various other ways. The term catarrh is derived from two Greek words, *kata*, down, and *reo*, I flow, a flowing down, and is so called because of the increased secretion—defluxion—that pours out from the inflamed mucous membrane of the nose, throat, &c., specially during the early stage of the disease. It is a disease to which all are more or less liable; and one attack never gives security against a second. Some people, indeed, seem very prone to it, and are very frequently attacked by it. It is not in itself a serious disease, though it is one very inconvenient, and producing great discomfort. Yet it must always be promptly and carefully attended to, since it is capable of leading on to much more serious diseases, of which bronchitis is the most common. If not properly attended to, it may be but the first step of a long period of illness, in which the lungs may become very seriously affected.

The **symptoms** of catarrh often begin with a sense of chilliness and shivering. There is fever, sometimes slight, sometimes severe, and a sense of weariness, with pains in the limbs and back. Sometimes the person feels as if he had been beaten or bruised all over. The skin is hot and dry, the pulse is quick, there are thirst, dryness of the tongue, and loss of appetite. The urine is less than usual, of a dark colour; and there falls a copious brownish deposit on cooling; and the bowels are constipated. Apart from these general symptoms, there are others, affecting particularly the nose, throat, and chest. Commonly the nose is first affected. It is dry and stuffed, and the person has to breathe through the mouth. The stuffiness is due to swelling of the lining membrane, the blood-vessels of which are more filled with blood than usual; and the membrane is thus red and irritable. The cold air acting on the irritable membrane causes fits of sneezing. The membrane lining the nose is continuous with that of the eyelids, which also partake of the increased blood supply, and are consequently red and watery-looking. In a short time the dryness of the nostril yields to a flow of thin, irritating fluid, requiring constant use of a handkerchief. The irritating character of the discharge is seen by the redness and tenderness which it produces on the lip and parts over which it flows. Accompanying these symptoms are loss of the sense of smell, a feeling of fulness about the bridge of the nose, and brow-ache. This group of symptoms constitutes "cold in the head," or **coryza**. The copious discharge from the nostrils does not continue long, and is succeeded by a secretion of thick matter, which indicates the diminution of the inflammation of the membrane of the nose, also signified by the nostrils becoming less blocked.

We have said that the mucous membrane lining the nose is continuous with that lining the eyelids (through the tear-canal; see section on the Eyes), and that this explains the participation of the eyes in the inflammatory process. But the same membrane is also continuous with that of the throat (see Fig. 88, p. 136); and so, as one would expect, the inflammation is not confined to the nostril, but travels backwards and downwards to the throat.

The symptoms associated with the throat are similar to those of the nostril. The mucous membrane becomes swollen and intensely red. The throat is also painful. The first feeling of the throat being inflamed is frequently that of a tingling, pricking sensation; and when, in consequence, the person looks at his throat in a glass, the unnatural redness of tonsils and fauces is perceived, at first, perhaps, only on one side, but ultimately on both sides. The tonsils frequently swell considerably, so that swallowing is painful and difficult; and the uvula may be much enlarged and baggy, so as to reach down and touch the upper surface of the tongue. There is from the throat a secretion of thick mucus. The same circumstance that explains the extension of the disease from the nostrils explains its extension down the throat to the windpipe. This occasions a dry, harsh cough, which begins a day or two after the onset of the cold. If the windpipe be to any

extent affected, the constant coughing induced, the pain over the chest so caused, the sense of oppression in the chest that arises, and hoarseness, constitute that stage of the disease called "cold in the chest." The popular phrase that the "cold goes down" into the chest is, therefore, quite a correct one. If the cold settles in the chest, then bronchitis and various other chest diseases may be induced, which will be considered in their proper place in the section on the RESPIRATORY SYSTEM. The stomach is also affected in the disorder, as the foul tongue indicates, it may be by the catarrh extending down the gullet to that organ. In still another direction the disease may spread, namely, up the tube—the Eustachian tube—leading from the throat to the middle ear. Swelling of the lining of that tube will block it, and so produce singing in the ears, and a temporary deafness, which are so annoying accompaniments of a common cold.

Such are the symptoms of a fully developed catarrh. But it is not necessary that they should all be present in each case; in one person the force of the attack may expend itself on the nostrils, and be evidenced by the "running nose" and weeping eyes. In another person the fauces may specially suffer; and in another, hoarseness and cough may be the chief signs of it.

The disease should last only from two to four days.

The **treatment** is simple, but may be easily made sufficient to lessen the severity and duration of the attack, and to avoid consequences which are too apt to follow neglect of all treatment. Let the person be confined to the house, and, if not to bed, at least to one room, which ought to be maintained at an ordinary temperature. The disease may be arrested, if treated at the very onset, by the person taking a warm bath, going straight to bed, and having a dose of 10 grains of Dover's powder, followed in a short time by a warm drink of gruel or similar beverage. *This dose must be given only to an adult.* The powder may be repeated, if necessary, every four hours, for three doses. In the absence of Dover's powder 20 drops of laudanum may be given, followed by the hot drink, and every three hours thereafter 10 drops with 7 of antimonial wine, for four doses, *but not to children.* The writer has found a catarrh snuff of Dr. Ferrier very serviceable, *but only if used at the very beginning of the cold.* It is made of 60 grains of powdered gum arabic, 180 grains of subnitrate of bismuth, and 2 grains of morphia. The ingredients must be thoroughly mixed and kept in a small wide-mouthed glass bottle. A good-sized pinch should be taken on the nail of the little finger and drawn up each nostril, the nose having been gently blown previously. This, *if taken early,* often succeeds in arresting the disease, and it soothes the irritation of the nostrils. An extra pinch may be taken every second hour for several times. *The snuff must not be given to children.* The unfortunate thing connected with the use of Dover's powder, laudanum, or the snuff, is that many people take badly to any preparation of opium. While any of the substances mentioned usually relieves all the symptoms, in some cases the headache is increased, and severe vomiting is produced. In such a case the irritability of the stomach will be diminished by sucking ice, which also will soothe the pain of the throat. On the morning following the use of any of these medicines a brisk purgative of seidlitz or other saline medicine should be given. If, after the acute attack has passed, the throat remains swollen, and secreting thick mucus, a gargle of alum, or chlorate of potash (of a strength of half to one tea-spoonful to a pint of water) may be used. If the nostrils remain swollen, and discharging yellowish matter, the same solution may be thrown gently into them by means of a syringe.

Much may be done to prevent attacks of such a nature by the health being maintained by active exercise in the open air, by the avoidance of great fatigue and then exposure to cold, and so on. A regular morning bath of cold water will also doubtless tend to diminish liability; but everyone does not take kindly to such an institution, and it would be a mistake to insist upon it, for so-called "hardening" purposes, if the person manifestly was none the better but rather the worse of it.

Inflammation of Tonsils (*Tonsillitis, Quinsy, Sore-Throat*).—Sore throat is an occurrence of many diseases, scarlet fever, diphtheria, &c. In this form, however, it is not a mere symptom as in the others, but the disease itself. It is usually the result of cold.

Symptoms.—The disease begins often by a shivering, or a sense of chilliness. The throat feels dry and painful, the pain being hot and stinging. At this stage the tonsils and neighbouring parts may be seen to be of a bright red inflammatory colour. Soon swelling occurs, and the tonsil projects from the wall of the throat. Frequently one side is attacked first, and the

other side a day or two later; but both may be attacked together. Owing to the tenderness and swelling, swallowing becomes difficult, and, if the case is severe, the swelling may become so great as almost quite to block the passage from the mouth into the pharynx. Speech becomes thick and difficult. The uvula becomes swollen also and red, hanging down often on to the back of the tongue, and provoking constant efforts to swallow or hawk up, from the feeling it produces of a foreign body being in the throat. The inflammation affects the glands of the mucous membrane, and causes an increased production of a thick mucus, which troubles the sufferer much, owing to the pain caused by efforts to get rid of it. The salivary glands may also be stimulated, by the increased circulation of blood in their neighbourhood, to excessive secretion, and the extra quantity of saliva produced is allowed to dribble out of the mouth to save the pain efforts to swallow it would occasion. The swelling may also prevent the mouth being opened sufficiently to permit of the condition of the parts being seen, and the pain may pass up into the ear. With all this there are frequently smart fever, quick pulse, and severe headache. After three or four days the symptoms begin to subside, and may quickly pass completely away. In other cases the disease is prolonged owing to an abscess forming on one side or the other. If not opened, the abscess bursts into the mouth, affording immediate relief to all the symptoms. A very short time after the matter is discharged, the person is usually able to swallow and to speak, though this may have been almost impossible to him before.

Sometimes the surface of the tonsils becomes dotted with whitish specks, which are formed by material from small glands, and which give the idea of ulceration taking place, and sometimes suggest diphtheria, to the ash-coloured spots of which, however, they have no resemblance.

Traces of acute sore-throat are often left in permanently enlarged tonsils, elongated uvula, &c., results which will be discussed immediately.

Treatment.—At the outset a smart dose of opening medicine should be administered. Saline medicine is best, salts, seidlitz, or similar preparations. The person should remain in his room, and indeed in bed. To relieve the pain hot cloths or poultices may be applied outside, and the vapour of hot water, inhaled from a jug, will help to soothe. Sloppy food is taken most easily when the swelling is severe. Even liquids are often returned through the nostrils in such cases. As to medicines, it is doubtful how much benefit can be derived from them in ordinary cases. The guaiacum mixture of the British Pharmacopeia is strongly recommended by some. It may be taken in doses of 1 to 3 table-spoonfuls thrice daily. The powder may also be employed, 20 to 30 grains, suspended in solution of gum, every six hours. At the very beginning an emetic of 20 to 30 grains of powdered ipecacuanha will help to shorten the attack. As for gargles, the tannic acid or alum and catechu gargle (see PRESCRIPTIONS—GARGLES) will be found useful. The best way to use such applications, however, is in the form of a paint. A camel's-hair pencil should be dipped into the mixture, and the mouth being opened as widely as possible, the affected parts are painted. This may be done often. The paint is most useful in mild cases. Anyone who has had an attack of sore-throat is always liable to another. He may know when it is coming on by a stinging in one tonsil, which is red and angry looking. At this period if the paint be freely applied it may prevent any further advance. In very acute attacks, however, strongly astringent gargles are not advisable, and mild gargles, of warm water and milk, for example, are preferable, and still more the use of steam of hot water as mentioned.

If an abscess forms the matter must escape, either by the abscess bursting or by it being opened. This latter should never be performed by any but a surgeon, as a large artery passes close to the tonsil, and runs the risk of being wounded by a careless or ignorant hand. Deaths from this cause have been recorded. Indeed in every acute case the care of a surgeon ought, wherever possible, to be secured.

Chronic Enlargement of the Tonsils is a common result of inflammation. The tonsils are permanently swollen and hard, and project sometimes so far as to interfere with speech and swallowing. This condition is specially annoying to public speakers, teachers, and singers. The voice is thick and easily fatigued, and the pitch of the singing voice may be seriously lowered. Breathing is noisy, especially during sleep. Partial deafness, from thickening of the membrane passing up to the ear, is not unusual. The paints recommended above may be applied in such a case. Touching with solid nitrate of silver is used, but is not advisable. It tends rather to maintain the irritation. If the

enlargement is of any size, the only satisfactory treatment consists in the cutting out of the tonsils—not a painful operation—or in burning them with a hot iron—not painful either. Of course a surgeon only can perform such an operation. To weakly women and children cod-liver oil should be administered, and syrup iodide of iron in ½ to 1 tea-spoonful doses.

The uvula like the tonsils may be permanently enlarged and elongated. It may be so long as to rest on the tongue and occasion a tickling cough and tendency to vomit. A small piece should be snipped off with scissors.

Relaxed Throat, in which the mucous membrane of the pharynx is thickened and produces a troublesome thick secretion, is the result of frequent slight colds. It is best treated by painting the back and sides of the throat with tannin and glycerine, or iron and glycerine (see PRESCRIPTIONS—GARGLES, &c.), or by the alum or chlorate-of-potash gargle. The frequent use of a spray producer, with solutions as recommended for clergyman's sore-throat (p. 287), is valuable. Doses thrice daily, of the iron and chlorate-of-potash mixture (see PRESCRIPTIONS) are also useful.

Obstruction of the Gullet (*Stricture of Œsophagus*), altogether preventing, or rendering very difficult, the passage of food and drink to the stomach, may be due to actual constriction of the tube, to spasm, or to some foreign body blocking the way. The former is a condition that arises from inflammation, such as would very readily be produced by the attempt to swallow some corrosive poison, like oil of vitriol, &c. The inflammation causes thickening of the walls of the tube and consequent narrowing of the passage. The chief sign is difficulty in swallowing—**dysphagia**. Such stricture can sometimes be overcome by the repeated passing into the gullet of tubes for the purpose of stretching it, larger and larger tubes being used as the passage gets wider. The process of widening requires to be continued for many months.

Obstruction by spasm occurs with hysterical women. That the obstruction is not due to organic disease is evident from the fact that the difficulty of swallowing is only temporary. It must be treated as hysteria, to which refer.

Obstruction from a foreign body is not uncommon. All sorts of substances, that persons have been holding in the mouth, have been known to slip down into the gullet and block the way. False teeth have been known to do it. Consequently, every wearer of false teeth, that are not tightly fastened, should remove them before going to bed, as this accident has often happened during sleep. Practically a large mass of something that one may have been eating, or that may have accidentally slipped into the gullet without proper preparation, may act the part of an obstructing foreign body—a piece of an apple, for example. If the substance is actually in the gullet, and not simply in the pharynx at the entrance to the windpipe, immediate danger is not great. A sense of choking is, however, felt. Breathing may be quite unaffected, though fits of a suffocative cough may be produced. Spasm of the top of the windpipe, due to the irritation of the foreign body, may arise and threaten to suffocate. The body itself, if allowed to remain too long, may produce inflammation, ulceration, &c. A surgeon will decide whether an attempt is to be made to get the foreign body up or to push it down. If it is some soft substance which may become acted upon in the stomach and broken down, the tube of a stomach-pump, gently passed down to the place where the body is fixed, may succeed in pushing it onwards into the stomach. A mass of meat frequently "sticks in the throat," in the pharynx, where it can readily be removed by anyone who knows how. Let the person's head be supported by the left arm, let his mouth be opened by the handle of a spoon or piece of wood, and then insert two fingers of the right hand into the mouth, pushing well to the side against the cheek. In this way the fingers will get well into the back of the throat and one may be able to sweep out or hook up the obstructing mass. (Refer to CHOKING, under ACCIDENTS AND EMERGENCIES.)

DISEASES OF THE STOMACH AND BOWELS.

Inflammations, Ulceration, Cancer, &c.

Inflammation of the Stomach (*Gastritis*) is in its acute form a very rare disease, unless when produced by the action of corrosive substances, such as vitriol, carbolic acid, &c., that have been swallowed.

Its **symptoms** are chiefly very severe pain over the region of the stomach and lower part of the chest, pain which is burning, and is increased by pressure over the part. Even the pressure produced by ordinary breathing greatly aggravates the pain, so that the person takes short, shallow, quick breaths. There are retching, hiccup, and vomiting, and loss of appetite. Nothing can be retained in the stomach. The

pulse is quick and small, there is fever, and the person becomes rapidly weak and exhausted. Death may occur very rapidly.

The **treatment** is largely determined by the cause. If an irritant poison, such as one of the mineral acids, has been taken, substances like chalk and water, magnesia, &c., should be given to destroy the burning tendency of the substance. The proper treatment for each case is considered in the chapter on POISONS. The general treatment consists in placing hot applications over the region of the stomach, in giving the person ice to suck, and in the use of opium, 1 grain every three or four hours. The opium, however, may not be retained in the stomach, so it may be given in injection (see INJECTIONS) or as a suppository (see SUPPOSITORIES). A medical man would likely administer it by injecting it under the skin.

Acute Gastric Catarrh (*Cold in the Stomach*).—This is an inflammatory condition of the mucous lining of the stomach (see p. 139), akin to the catarrhal condition of nose and throat that has been described. It is frequently due to cold.

Symptoms.—The person is very sick, and has severe headache. There are pain over the stomach and a feeling of soreness in the back and limbs. The vomit is of mucus, and is coloured with bile, which causes the disorder to be called a "bilious attack." The tongue is very much coated with a white fur. The pulse is quick and full, and the skin hot. Often the temperature will rise to 103°. The urine is dark, and a brick-dust deposit falls when it cools. Severe cases are called attacks of "gastric fever," though this is a term discarded by modern physicians.

The **treatment** consists in keeping the patient quiet in bed. Let food be rather avoided, and let what is taken be of a low sort, milk, &c. The sucking of ice will greatly check the sickness and vomiting. The most valuable medicine is a powder composed of 10 grains of Dover's powder and 8 grains of bismuth. The dose may be repeated every four hours for three or four powders. (*It is only for an adult.*) Thirst may be relieved by soda-water, or sips of iced water or iced milk. As soon as the acuteness of the attack has passed, the bowels (which the powders tend to constipate) should be freely opened by a dose of saline medicine, Eno's fruit-salt, seidlitz, or effervescing citrated magnesia, &c.

Chronic Inflammation of the Stomach (*Chronic Gastritis—Chronic Gastric Catarrh*) is a common disorder, and may be produced by a great variety of causes. Cold, the swallowing of irritating substances, irregularity in taking food, bad food, or food that is ill cooked and so not easily digestible, too much food, badly chewed food, and very particularly frequent use of stimulants, all these may occasion it. In addition, chronic inflammation may be the result of some other disease, such as a disease of lungs or heart, preventing a proper circulation of the blood, and so leading to constant over-fulness of the blood-vessels of the stomach and other parts of the alimentary canal.

The chief **symptoms** are loss of appetite and indigestion. There may be tenderness over the stomach. Vomiting of a large quantity of glairy mucus is common. Sometimes, instead of loss of appetite, there is craving for food, but, even though craving it, the person has taken only a small amount when sickness and a sense of overloading arise that make him desist. The bowels are usually confined; the breath is foul, and there is a bad taste in the mouth. Naturally the person suffers in general health, is low-spirited and irritable.

The **treatment** of such cases is sometimes very difficult. Much may be done without medicine by methods of feeding. If vomiting after food is a frequent occurrence, then very small quantities of food, chiefly milk, should be given often. Begin with a spoonful, and let it be repeated at intervals, and slowly increased as the stomach tolerates it. The stomach may be coaxed in this way to digest food which it would immediately reject if it were given in any quantity. If the bowels be constipated some medicine is necessary. In such cases nothing suits better than a saline medicine taken in early morning before breakfast. The Carlsbad salts obtained in crystals and dissolved in water (one or two tea-spoonfuls in a tumbler of water) are specially valuable. Failing Carlsbad, Hunyadi Janos mineral water (a claret-glassful) may be used, or some effervescing saline medicine. Stimulants should not, as a rule, be employed. Some tonic medicine should also be used if the stomach will tolerate it—iron, quinine, and strychnine, or an acid tonic (see PRESCRIPTIONS—TONICS). The person troubled with such an affection should also take mild regular exercise, should avoid salted and highly-spiced meats, and should avoid damp and wet.

Ulceration of the Stomach.—"An ulcer of the stomach" is, in the eyes of most people, one of the most hopeless of troubles. Yet

it is probable that a very large number of persons suffer from it, the symptoms being chiefly those of dyspepsia, and recover from it, and have no suspicion as to the true cause of their indigestion. Undoubtedly ulcers may end in death after long and painful suffering, but, as undoubtedly, they very often end in recovery.

Women seem more liable to the disease than men, and it is commonly associated in women with derangement of the monthly periods and bloodlessness. It may also be the results of dissipated habits and of syphilis. It is a disease of middle life, and the liability to it increases as life advances.

The history of an ulcer of the stomach may vary. It is first limited to the inner coat—the mucous membrane—and may be of such a nature as if a piece of the membrane had been punched out. The tissue surrounding it is increased in amount, through an effort of nature to repair the breech. This effort may be successful, and the rampart of thickened tissue, thrown up, as it were, round the ulcer, may gradually encroach on it, the ulcerated surface narrows more and more till it is obliterated, and nothing may remain but a depressed puckered scar. Why this does not speedily take place is doubtless due to the constant worrying to which a healing ulcer is subjected in the stomach by the movements of the stomach walls, by the passage of food of all kinds over it every now and again, and by the irritation of the gastric juice, poured out whenever food is admitted into the stomach. The stomach ulcer wants that first requisite for speedy recovery—rest. Doubtless very often the ulcer does not heal because of the general condition of the person's health or the special condition of the blood, a person with bloodlessness (anæmia) or syphilis, for example. If the ulcer does not heal it may spread, extending itself gradually over wider portions of the mucous membrane, and growing more deeply into the stomach walls, the patient, all the time, becoming more and more exhausted, and finally dying of exhaustion. In the course of eating its way through the walls of the stomach, the ulcer may open into a blood-vessel and cause serious bleeding, ending in death either by sudden and great loss of blood, or by exhaustion produced by several attacks of bleeding. The ulcer may eat its way entirely through the walls of the stomach, producing perforation, so that the contents of the stomach escape through the opening into the cavity of the belly and there set up inflammation (peritonitis), which speedily kills. Instead of making an opening into this cavity, the ulcer may be in such a position that it opens into the large bowel behind, or at the surface of the pancreas, or other part to which the stomach may have become adherent by the inflammatory process which the progress of the ulcer has set up. In a case where the stomach is adherent at the seat of ulcer to some other organ, actual perforation may be prevented by the adhesions, and peritonitis not arise. In the event of the stomach being adherent to the large bowel behind, the ulcer might eat its way through the adherent walls of both organs, and thus a communication exist between stomach and large bowel. Food might thus pass directly from the stomach into the large bowel, and nourishment be thus seriously interfered with. Similarly fæces might pass from the large bowel into the stomach and be vomited by the person.

The **symptoms** of ulceration of the stomach are chiefly pain, vomiting, especially vomiting of blood, and general dyspeptic symptoms. Indeed, at first, the symptoms are chiefly those of dyspepsia, such as have already been described under CHRONIC INFLAMMATION OF THE STOMACH, bad appetite and bad digestion, fulness after food, flatulence and uneasiness after food. When the symptoms have grown worse, so that pain is actually developed, it may be felt over the stomach or at the back on a level with the beginning of the lumbar vertebræ, or between the shoulders. The pain is increased on pressing over the stomach. It is aggravated after food, reaching its greatest intensity at a varying time after food. It may be caused by the entrance of food into the stomach, and may arise immediately or a few minutes after the food has been taken, and is of a burning character. It lasts till the food may be supposed to have passed on to the small bowel, or till vomiting has occurred, emptying the stomach and so producing relief. Vomiting may become so frequent as to occur some time after every meal, and is a serious element in the disease, since the nourishment of the patient is thereby gravely affected.

Vomiting of blood (*hæmatemesis*) is an occurrence of ulceration owing to some blood-vessel being opened into. A large and sudden loss of blood may in this way occur, tending to cause the speedy death of the person by collapse, or frequent bleedings may take place, which very quickly reduce the patient's strength. The ordinary vomit consists of the food partly digested and of mucus; but, if mixed with blood not in sufficient quantity to be recognized as

such, there is the appearance of "coffee grounds," due to the blood being altered by the action of the gastric juice.

If the ulcer open into the cavity of the belly it will be known by sudden severe pain, great prostration and anxiety, and the speedy occurrence of inflammation of the whole cavity of the belly, the symptoms of which are described under the heading PERITONITIS (p. 190), which speedily ends in death. This termination of the disease may be encouraged by a good meal, or by some exertion which exerts pressure on the wall of the stomach, and so bursts through its weakened portion.

Treatment of ulceration of the stomach demands the care and skill of a physician. Of course the recognition of the disorder equally requires a well-trained physician. The symptoms that have been mentioned will enable anyone to recognize a serious condition requiring careful attention. But for the treatment it is not enough even to be sure of the fact that an ulcer of the stomach exists. For the treatment of this disease, as of almost all others, requires the consideration of many other circumstances. It is often a difficult question even for a skilled physician to give an opinion as to the presence or absence of ulcer; but even though he is convinced of the existence of ulceration, the question of treatment may be one of difficulty. Therefore, if this condition is even suspected, medical aid should at once be sought. The principles that guide the treatment may, however, be indicated. One great object is to give the stomach rest, and secure for the ulcer time to heal and freedom from worry. This could be done by keeping the person quiet, lying flat in bed, and giving the stomach no work to do, that is, by giving no food by the mouth, for it is the introduction of food that excites the movements of the stomach and the secretion of the gastric juice. Another main object is to maintain and, as far as possible, increase the strength of the patient, so that there may be material and vigour for the healing process. Clearly, however, these two objects are to some extent antagonistic. To rest the stomach and yet increase the person's bodily strength is not an easy task. It is best accomplished by giving such food as milk, slightly thickened with arrow-root or biscuit powder, &c., and giving it in *very small quantities frequently repeated*, a table-spoonful every hour or oftener, for example. The food is unirritating and does not distend, and very slightly excites the stomach. The food should always be given tepid and never hot or cold, for a similar reason. This diet may be reinforced by nourishing injections. (See list of nourishing injections, p. 873, and for use of injection apparatus refer to section on MEDICAL AND SURGICAL APPLIANCES.) In some cases the use of raw pounded beef, given also in small quantities, has proved useful. Various medicines are recommended. Bismuth, in doses of 8 to 20 grains with ½ to 1 grain of opium, given twice or thrice daily, relieves the pain and helps the healing process. Hot applications to the region of the stomach are also soothing. If bleeding occurs no food is to be given for one or two days, nourishment to be maintained by injections, ice to be sucked, and doses of 10 grains of gallic acid, or 15 drops tincture of steel, to be given every six hours, to cause contraction of the bleeding vessels, the person being all the time kept perfectly quiet.

Perforation of the wall of the stomach, occurring as the result of ulceration, is known by sudden severe pain, followed by collapse or great prostration. The pain rapidly spreads over the whole belly, owing to the occurrence of inflammation of the lining membrane of the cavity—the peritoneum (see p. 130). Death may occur a few hours after the perforation.

Cancer of the Stomach is not an uncommon disease, though it seldom occurs before the age of forty. It may exist in any of its various forms. (See CANCER.) Life is seldom prolonged beyond two years after its commencement.

Its **symptoms** are not always marked, and may be those of dyspepsia such as might arise from chronic catarrh. Many cases are recorded of death from cancer, in which there were no symptoms which could have led any one to suspect the true nature of the disease. In most cases it is, therefore, a question of great difficulty for even a skilful physician to decide whether a person is affected with cancer of the stomach or not. Apart, consequently, from such skilled opinion, no one ought to conclude that he or she is affected with this disease, since very simple affections of the stomach may produce similar, and even more severe symptoms. It would be well if this warning were laid to heart. Many people are so constituted that to tell them they are affected with cancer is to issue their death-warrant. It produces such an effect upon them as to lead to their death even suppose they have no cancer, but, perhaps, merely some chronic catarrh. The parts of the stomach most commonly affected in cancer are, firstly, the neighbourhood of the junction between the

stomach and the small intestine (the pylorus); and, secondly, the junction between stomach and gullet. The thickening, which is a common result of the disease, is apt to narrow the opening, so that the passage from stomach to intestine is contracted in the one case and that from gullet to stomach in the other. In the former case the food, which has been digested in the stomach, finds its onward passage obstructed. It is thus retained in the stomach and vomited after a longer or shorter interval, probably an hour or two after being swallowed. The vomit will consist of the partially digested food, mixed with secretion from the stomach. If the cancer has undergone ulceration and sloughing, the vomit will contain very offensive matter discharged from it. From the ulcerated surface also there is likely to be oozing of blood, which will have the appearance of coffee ground, because of the action on the blood of the contents of the stomach. *The coffee-ground vomit is very suspicious of cancer.* Sometimes obstruction at the pylorus leads to accumulation of food in the stomach for a considerable time. This leads to expansion of the organ. The accumulated food is at length vomited, and so an enormous quantity may be vomited at one time. (See DILATATION OF THE STOMACH, p. 162.) If the obstruction is at the gullet opening, then food which is swallowed will pass down a considerable way, and then, not able to get into the stomach, will be immediately returned.

Besides such symptoms there will be loss of appetite, pain, and vomiting, which is likely to occur even though no such cause as that of obstruction to the onward passage of the food be present.

No **treatment** for the cure of the disease is known. The treatment, consequently, is merely palliative—employed, that is, for the relief of pain and such symptoms. Proper nourishment must be given in a form that is easily digestible —milk, beef-tea, fish, eggs, &c., given in small quantities often, to overcome irritability. Sooner or later, in most cases, opium is resorted to to relieve pain. The longer this can be delayed the better, since the use of opium grows upon patients. A dose sufficient to induce sleep at first soon becomes too little, and increasingly larger and larger doses require to be administered. Not more than 1 grain should be given to begin with.

Bleeding from the Stomach (*Hæmatemesis*).—Blood may escape from the vessels into the cavity of the stomach in many kinds of disease. In cases of ulceration, either simple or due to cancer, the quantity may be very large. Simple congestion, due to disease in the walls of the stomach itself, or because of obstruction to the passage of the blood by disease of the liver, for example, or disease of the heart, may also occasion it. Hæmorrhage from the stomach also occurs in scurvy and a disease called purpura, to which refer. It must also be noticed that a considerable number of cases have been known of women who had no regular monthly discharges from the womb, but had monthly discharges of blood from the stomach or lungs. Cases also have occurred where suppression of the monthly flow was followed by discharges of blood from the stomach. If it escape in any quantity it is likely to be vomited, and to be easily recognized. The coffee-ground appearance of the vomit due to altered blood has been referred to under ULCERATION and CANCER OF THE STOMACH. Blood may escape into the stomach, and, not being vomited, will pass on into the bowels, to appear in the stools. It does not then appear in its usual colour, because of the action of the various intestinal juices on it, but makes the fæces black and tarlike. Of course if the presence of blood be evident in the fæces there is nothing to show whether it has come all the way from the stomach or from the intestines only.

Symptoms.—If a large quantity of blood escape suddenly into the stomach there may be faintness, pallor, insensibility. Sometimes the sudden loss of large quantities of blood produces convulsions because of the want of blood in the brain. Immediately, or within a short period, vomiting of the blood will occur and reveal the cause of the faintness. Vomiting of blood is to be distinguished from spitting up of blood from the lungs. The former occurs after some feeling of sickness; the latter is not vomited but coughed up, after some tickling in the throat. Blood from the lungs is usually bright and mixed with air, that from the stomach is usually dark.

It should be noted that blood that is vomited does not necessarily proceed from the walls of the stomach. It may have proceeded from the back of the nasal passages or throat, and may have been swallowed unconsciously, to be afterwards vomited. In all cases, therefore, the back of the throat should be examined. Sometimes a streak of blood will be seen passing down from the position of the opening of the nasal cavity behind, indicating the source of the blood.

Treatment should never be adopted without

proper medical advice. The reason of this is readily understood. Suppose the bleeding to be due to opening of some blood-vessel by ulceration, what are called *styptic* remedies are employed, remedies like gallic or tannic acid and tincture of steel, which act by contracting the bleeding vessels. But suppose the bleeding to be due to escape of blood from gorged blood-vessels, whose congestion is due to the liver, plainly styptic remedies are useless, and a successful plan of treatment must remedy the liver defect and so relieve the too full vessels. Again, should the bleeding be an effort of nature to get rid of a discharge by this channel, when the ordinary channel of the monthly flow is denied to it, it is clear that, besides giving medicines like tincture of steel or ordering the sucking of ice to arrest the discharge from the stomach, efforts must be made to restore the usual and regular discharge. It is necessary to repeat, therefore, that if rational treatment is to be adopted qualified advice should be sought, so that not merely the escape of blood, but the cause of that, should be taken into due consideration. However, it is well to know, in case of some delay in getting advice, and where copious discharge of blood exists, that the person should be kept quiet and at rest in the horizontal position, that ice should be given to suck, and no warm food or drink permitted, and that doses of tincture of steel (15 drops) or gallic acid (5 grains) should be given to contract the vessels.

Dilatation of the Stomach has been commented on in the preceding paragraphs on cancer. Mechanical obstruction to the passage of food from the stomach to the small intestines, such as a tumour can produce, will readily cause dilatation or expansion. It appears, however, that dilatation may exist without any such obstruction. Habitual overfeeding or improper feeding may occasion it.

The **symptoms** are fulness in the region of the stomach, flatulence, heartburn, uneasiness, and vomiting. The quantity vomited is often very large, several meals being sometimes retained and then rejected together. Owing also to the want of regular complete emptying of the stomach, fermentive changes are set up in the stomach, and as a result the vomit may have a sweetish taste.

The fermentation in such cases is frequently set up by the presence in the stomach of the *yeast fungus*, or of another active agent in fermentation called *sarcinæ*. They are detected by means of the microscope.

Treatment of such cases requires patience and adaptation to the particular instance. Thus a case of dilatation pure and simple would obviously be much more easily treated than one due to obstruction. In any case small quantities of light easily-digested food should be given at a time. Besides that, the occasional passage of a stomach-pump so as to wash out and completely empty the stomach is very useful, but cannot be performed but by skilled hands. In some cases of simple uncomplicated dilatation remarkable results have been obtained by administering, early every morning before breakfast, four tea-spoonfuls of the Carlsbad Spreudel-saltz dissolved in a pint of water, the whole pint to be taken at once. [The salts are obtained in bottles from chemists, but they are rather expensive.]

Where sarcinæ are suspected to be the cause of fermentive changes in the food in the stomach, 20 to 60 grain doses of the hyposulphite of soda should be given.

Inflammation of the Bowels (*Enteritis*).—There are several forms of inflammation of the bowels of great severity and very fatal. One form, which will be described here, is not so serious, and partakes rather of the nature of catarrh, as described in connection with the stomach. Instead of being called inflammation of the bowels it ought rather to be called **intestinal catarrh**. As has been already noted (p. 154) catarrh, beginning in the nasal passages, may pass to the throat, onwards to the stomach, and may also pass from the stomach to the remainder of the alimentary canal. Further, even as irritating substances may produce catarrh of the stomach, so may catarrh of the small or large intestine be occasioned. There can be no doubt that improper food may occasion it, specially in children, who seem liable to it at the period of teething. In children the disease is apt to be very severe, and to prove fatal, from the speedy exhaustion of the child. (See DISEASES OF CHILDREN.) It is not doubtful that in the summer months the use of herrings and new potatoes, as well as the eating of overripe fruits, has been a very frequent cause of such catarrh of the intestinal tube. It is the mucous lining of the intestines that is affected, which becomes swollen and congested, and pours out a copious secretion of mucus. Like catarrh occurring in other situations the disease may be acute or chronic.

The **symptoms** of this form of inflammation are uneasiness or positive pain and griping in

the bowels, sickness, vomiting, and purging. The vomiting and purging are sometimes very severe. The vomit is mucous, and later bilious, giving rise to the idea that it is a bilious attack. The discharge from the bowels is mucous or watery and irritating, and very abundant. What is worse is the straining at stool and the frequent desire to go to stool without any result. Accompanying these, which are often the first symptoms, are fever, which may even reach 103°, furred dry tongue and foul breath, loss of appetite, and severe headache. The skin is also dry and burning. It is important to note that while the belly may be tender there is no great pain on pressing it, and no particular spot specially painful. This, among other things, distinguishes the disease from a severer form of intestinal inflammation, and from peritonitis, which will be described later.

Treatment.—If the catarrh is due to some irritating substance, then the purging, &c., is to some extent an effort of nature to expel it, and in such circumstances a moderate dose of castor-oil as a preliminary would doubtless be beneficial. It should be followed in about an hour by a dose of ipecacuanha and opium in the form of Dover's powder, 10 grains (*for adults only*), and this dose may be repeated, as seems desirable, every three or four hours till the purging and vomiting cease, when its administration should stop, an occasional dose being given should the griping and purging seem about to return. With the Dover's powder 10 grains of bismuth may be conjoined. It often happens that no sooner is a powder given than it is vomited. In such a case the use of ice is wonderfully relieving. The patient may be allowed to suck small pieces of it, or may be allowed sips of iced milk. When the irritability of the stomach is in this way allayed a little, a second powder may be given. A warm application to the belly is also very grateful to the patient. Accumulations of wind often distress the person and occasion colicky pains. For these, as well as for a stimulant, when the first acuteness of the attack has passed, a tea-spoonful of the ammonia-and-ether mixture (PRESCRIPTIONS—STIMULANTS) may be useful. Should the person become faint the brandy-and-egg mixture (see PRESCRIPTIONS—NOURISHING MIXTURES, &c.) should be used. Stimulants, however, are not to be employed, as is too often the case, as a matter of course, but only if really necessary. As to food, the iced milk will be sufficient at first. Later, mutton broth rid of fat, milk, &c., should be given. When the attack is over, the patient is generally very weak, requires good nourishing food, and tonics such as that of quinine and iron.

In the **chronic** form of catarrh of the bowels there are also griping pains, watery offensive stools, indigestion, and consequent weakness and falling off in health of the patient.

It should be treated with simple food. Pounded raw beef or raw eggs may be tried, with quinine and iron, syrup of phosphates of iron, and change of air.

There is another form of inflammation of the bowels which will be merely noted here, which is of great danger and demands skilled and attentive treatment. In it not only the mucous lining but the whole thickness of the part of the bowel affected is more or less inflamed. It is also paralysed by the inflammation, so that, while the healthy part of the bowel below is narrow, the inflamed part becomes greatly distended. The distended portion becomes filled with fæcal matters which cannot pass onwards. Constipation instead of purging is, therefore, a feature of this disease. There is also vomiting, the vomiting after a little becoming brown, foul, and distinctly fæcal. There are severe colicky pains, and there is *pain on pressing on the belly*. These features are sufficient to distinguish this disease from mere constipation or from mere colic. For the latter purgatives and stimulants are the common remedies, and these would but add to this disease, and indeed seriously aggravate it. Opium is the chief drug required for its treatment, given in 1-grain doses to relieve the pain and keep the bowel quiet. Hot applications to the belly are also useful, and warm water injections by the rectum. In some cases, however, at the very onset the removal of blood by lancet or leeches may be of the utmost value, and therefore no delay should be allowed to occur in summoning a physician, if this form of intestinal inflammation is suspected. The disease tends to kill in a few days, sometimes in a few hours, by exhaustion, and all the resources of a physician will frequently be taxed to fight it out. For these reasons, these indications of the disease only are given.

A very severe and fatal inflammation sometimes occurs in the walls of the cæcum (see p. 130) and the surrounding tissues. It is called **typhlitis** or **perityphlitis**. It is specially apt to occur in connection with the vermiform appendix (Fig. 86, p. 130), perhaps from the effects of the lodging in that part of the bowel of a piece of egg-shell, a fruit stone, orange-pip, &c. There are great pain, tenderness, and swelling at the upper part

of the right groin. Till a physician can be obtained the person ought to be kept strictly quiet in bed; hot cloths may be applied over the painful part, and a 1-grain opium pill may be administered every three or four hours.

Ulceration of the Bowels.—It is useless in such a work as this to note any special features regarding ulceration of the bowels. Any mention of symptoms would be only misleading, since by unskilled persons much simpler affections might be mistaken for this disease, and much distress and anxiety thereby occasioned to the patient. But ulceration of the bowel may occur just as ulceration of the stomach, and may, in the same way, eat its way through the bowel wall and occasion adhesions between the bowel and other organs by the consequent inflammation, or may open into the abdominal cavity and set up inflammation there. (See PERITONITIS, p. 190.) Ulcerations are a chief feature in typhoid fever, the glands of Peyer (p. 140) being specially their seat. They also occur in syphilis and in tubercular disease.

Obstruction of the Bowels (*Stoppage of the Bowels*) is a very serious complaint, is indeed very fatal, and more fatal than it might be, because of the fact that it usually is some days before the true nature of the illness is recognized. Valuable time is therefore lost, and injurious treatment is very likely to have been adopted under the belief that the trouble is only extreme costiveness. Obstruction of the bowels may be produced in various ways. It may be due to foreign bodies, fruit stones, marbles, &c., which have been swallowed. A single fruit stone is not likely to produce it; but, if a number of them has been swallowed, they may become massed together to form an obstacle sufficiently large to completely block the bowel and prevent the onward movement of the contents. Moreover, if a person has been long in the habit of taking regular doses of such a powder as carbonate of magnesia, it seems quite possible for a mass of hardened material to be slowly formed of magnesia which has been taken, which in the end may be large enough to block the passage. Gall-stones which, by some means, have forced their way from the gall-bladder into the bowel, may also become obstacles. Besides by such mechanical obstructions, the tube may be closed by accumulations of hardened fæces, or by some inflammatory process which has gradually narrowed the channel by thickening of the walls, and which, after a long period of tendency to constipation, often suddenly ends in complete obstruction. It may be closed by tumours such as cancer. It may be closed by coiling and twisting of the gut on itself, or by the gut becoming bound down by adhesions due to inflammation, or by the bowel slipping into some narrow opening in the surrounding tissue and becoming there strangled. Rupture may become strangulated, and so produce obstruction. (See RUPTURE, p. 191.) Lastly, what is called intussusception may occur, in which one part of the bowel slips into another, as one part of the finger of a glove may be slipped within another part. This is commonest among children.

Symptoms.—It is usually, however, quite impossible to tell what is the cause of the obstruction. The main fact is that the person can obtain no passage. This may happen suddenly, without any previous warning, or after a long period of tendency to constipation, uneasiness, colicky pains, &c. Besides the obstinate constipation, there are sooner or later sickness and vomiting, painful colic due to peristaltic movements of the bowel (p. 145), which is endeavouring to free itself. These movements are sometimes seen through the walls of the belly. Great distention from wind adds grievously to the distress. The vomiting is at first of the contents of the stomach, and later of fæcal matter churned up by the movements of the bowel. If the small intestine is blocked, the vomiting is likely to occur sooner than if it were the large intestine in which the obstruction occurred. When the bowel is strangled, the vomiting occurs speedily; the pain suddenly comes on, the belly swells quickly, and death within a few days is apt to occur.

Treatment.—It is apparent that no time is to be lost in treating such a condition of affairs. Usually, in an ordinary form of obstruction, where the symptoms take a little time to develop, the person and his or her friends think it is mere costiveness that is the cause of all the symptoms, and purgatives are tried, dose after dose, of various kinds, each stronger than the other, till the doctor is summoned, often when the patient is already sinking. Purgatives are right enough to begin with, when the true nature of the case is not certainly known; but after it is evident that they fail to secure a passage, their continuance is a great mistake, since they cause only a greater accumulation of material above the site of the obstruction, add to the distention of the bowel above that point, and seriously aggravate the distress. On the other hand, no harm, but good, arises from large

and repeated injections of warm water by the rectum. For repeated large injections will help to wash away any accumulations of fæces, and will also tend to aid in the uncoiling of any twist, while, the water having a free outlet, no danger need be feared, if the water is injected carefully and slowly. Large hot poultices should be applied to the belly, and, to relieve the pain caused by the movements of the bowel, 1-grain doses of opium (*to adults only*) should be given every three or four hours. Careful filling of the bowel with air by the use of bellows adapted for the purpose, the nozzle of which is inserted into the anus, has been successfully used for twisted bowel, and specially for intussusception. It should only be employed by skilled hands, otherwise much mischief may be done.

Such is an indication of the treatment to be adopted. Yet it cannot be too much insisted on *that these are cases to be treated by skilled men from the commencement.* Because (1) the whole cause of the obstruction may be a rupture which is not visible outwardly, and which a doctor would carefully examine for, and, if found, perhaps liberate by an operation, and because (2) where there was reason to believe that the cause of the disease was a twist of the bowel, or it being bound down by some bands of adhesion, a surgeon would probably suggest, other things failing, the desirability of opening into the cavity of the belly to discover and, if possible, uncoil or liberate the twisted or confined bowel. Such operations must, however, be done before the patient has begun to sink, in short, as early as possible. Cases are on record where a simple twist, or the binding of the bowel by a narrow band, has been the cause of the whole mischief, and where an operation has relieved and saved the patient. Patients, judging from the pain, &c., have been able to predict the exact place of the stoppage, and surgeons have also been able to do the same by external examination, or by judging of the quantity of water that could be injected by the rectum before the obstruction was reached. Valuable indications for the place of operation have thus been obtained.

Intussusception is the passage of one part of the bowel within a succeeding part of it, just as one may push half of the finger of a glove within the other half. It is also called **invagination.** The part pushed within the other is strangled, and the circulation stopped in it, so that it becomes swollen, congested, and may die. Besides, the result of the intussusception will be to block the canal of the intestine, and so produce obstruction of the bowels. It is a disease occurring most commonly among children, and therefore will be considered in the chapter devoted to DISEASES OF CHILDREN.

Foreign Bodies in the intestine have been already referred to under OBSTRUCTION OF THE BOWELS as a cause of blocking of the intestinal tube. In that article it has been mentioned that fruit stones, marbles, &c., that have been swallowed, may form masses in the bowel sufficient to block its fair way. Besides these, paper, husks of grain, pieces of egg-shell, fibres, or hairs of various kinds may become matted together with the fæces to form masses. Specially should it be noted by persons in the habit of taking large and repeated doses of powders like magnesia, chalk, phosphate of lime, &c., that these may form concretions in the bowel, which may gradually grow large enough to obstruct the bowel. Doubtless the presence of such masses will tend to irritate the bowel, and occasion irregularity of the bowels, and other disturbances, perhaps occasional diarrhœa. Besides, they may settle down in some corner or pouch, set up inflammation, and in the end cause perforation of the bowel. The symptoms that arise when they obstruct the bowel have been referred to. (See OBSTRUCTION OF THE BOWELS.)

Consumption of the Bowels (*Abdominal Phthisis, Tabes Mesenterica*).—The English word *consumption*, the Greek word *phthisis*, and the Latin word *tabes* are terms all used to imply a wasting away. When "consumption" is spoken of, it is commonly understood as applying to the lungs, and the popular phrase, "consumption of the bowels," if correct, would imply some resemblance between consumption as affecting the lungs and a disease affecting the bowels. In point of fact there is such a resemblance. Consumption as affecting the lungs may arise apparently from several causes, but one common cause is a disease called "tubercle," or "tuberculosis." The general disease to which the term "tuberculosis" is applied is briefly considered elsewhere. (See INDEX.) It is sufficient to state here that it consists in the formation of small greyish bodies, or nodules, composed of round cells, to which the name tubercles is given. The tubercles may occur in many of the organs and tissues of the body, but they are most common in the lungs and mucous membrane of the intestines. Now, the little tuber-

cles tend to break down and to form a yellow, cheesy material, the dead and worn-out remains, as it were, of the cells that, in its early stage, formed the grey nodule. Further, the tissue immediately surrounding the nodule tends to become involved; in plainer words, the tubercle spreads, and, as it spreads round the margins, the central parts break down into the cheesy matter. It becomes evident, therefore, how a nodule, which at first was so small as to be barely visible to the naked eye, may grow to a considerable size, and evident also how its growth means the destruction of the tissue in which it happens to be. For if the central parts soften and break down, an ulcer will be formed, and with the spread of the tubercle there will be increasing size of the ulcer. Now, let this process be going on in the lungs and intestines, the chief seats of tubercle, and there is actually a consuming, a wasting-away process, going forward. This is the process that goes on in one form of consumption of the lungs, and is the process that goes on in the disease we must here briefly consider. It is worthy of remark that it is the presence of tubercles in the membranes of the brain that occasions "acute water in the head" (p. 101).

In the bowels the tubercles are found most numerously about the glands of Peyer, mentioned on page 140, and, as already indicated, by their softening they form ulcers, which have a marked tendency to spread, so that there may be large and numerous patches of ulceration in both the small and large intestines. Now, this ulceration may eat into a blood-vessel, and so cause death by loss of blood; or it may work its way quite through the bowel wall, and so open into the cavity of the belly, setting up fatal inflammation there; or, if the ulcers heal, the scars they form may so pucker the wall of the bowel as to diminish seriously the size of the tube. More than this, material from the softened tubercles, passing into the lacteal vessels (described on page 145), will reach the glands of the bowel, and will set up the diseased process there, so that glands may be converted into masses of cheesy material. Under the influence of the diseased process the glands become enlarged and hard, and in marked cases of the disease the hardened masses may be felt through the belly wall.

The disease specially affects children.

The **symptoms** may be various, dependent on the exact seat of the tubercles, whether on the outer or inner coat of the bowel. Generally they are such as these: griping pains in the bowels, irregular action of the bowels, probably looseness, which tends to grow worse, swelling of the belly, which becomes hard and tender. In advanced cases the hardened glands may be felt through the abdominal walls. There are also extreme wasting, feebleness, and thinness of body, mainly because the lacteal vessels, by means of which nourishing portions of the food are conveyed from the bowel into the blood, are affected by the disease. Recovery does sometimes take place from consumption of the bowels, but, on the whole, rarely.

Treatment is mainly directed to keeping up the strength of the patient. For this purpose, besides a nourishing, easily digested diet, consisting of soups, beef-tea, milk and cream, eggs, &c., chemical food (syrup of the phosphates of iron), syrup of the iodide of iron, cod-liver oil, quinine and iron tonic, &c., are prescribed in doses proper to the age. The patient should be removed to a suitable locality, sea-air being desirable, and should be clothed with warm clothing, flannel surrounding the belly, and should sleep in a large, well-ventilated room. Pain in the belly should be relieved by hot applications. Costiveness or diarrhœa, &c., occurring in the course of the disease must be treated as such affections require. (For directions on these points refer to the paragraphs on Costiveness, &c.) It must be noted that preparations of opium are largely used for the relief of pain and for diarrhœa, but that the administration of opium to children, in whom the disease is common, unless ordered specially by a medical man, who also prescribes the dose, is attended with grave risks. For that reason the main plan of treatment only is indicated here, but the multitude of accompanying complaints, incidental to the disease, cannot be properly treated by any but a qualified medical man.

Bleeding (Hæmorrhage) from the Bowels (*Melæna*).—When blood passes from the blood-vessels into the canal of the bowel, it is acted on by the digestive fluids and is made black, and frequently quite tar-like, the red colour being completely lost. From the black and tarry appearance of the motions which are subsequently passed, the term melæna is applied to the condition, from the Greek word *melas*, meaning black. If, however, the blood, which has gained entrance to the bowel, is passed too quickly for the digestive fluids to act upon it, it will retain its red colour. If, for instance, it comes from the rectum, it will be of the ordinary

bright colour. The passage of blood is not to be considered a disease in itself; it is to be considered as an indication of a disease, and whether it is to be regarded as a very serious fact or one of no great consequence depends entirely on what it is supposed to signify. What it does signify may frequently be quite evident, at other times the settlement of this question may be very difficult, and demand a careful examination by a skilled person. For example, bleeding from the bowels occurring in the course of typhoid fever means the opening into a blood-vessel by the process of ulceration of the bowel. That is one of the main occurrences in this fever, and a similar thing occurs in ulceration from tubercle, cancer, &c. It may also occur because of congestion of the blood-vessels of the mucous membrane of the intestine, which may be due to inflammatory affections of the bowel, or to congestion and other conditions of the liver impeding the course of the blood, and so producing stagnation in the capillary blood-vessels of the intestines, which, as we have seen (p. 140), are the beginnings of the portal vein of the liver. It is plain how any obstruction to the passage of the blood along the portal vein will speedily act backwards on the small vessels of the intestine, and how the pressure of the dammed-up blood may cause the oozing of a considerable quantity through the walls of the distended vessels, or may even burst some of them. Constant drinking is a frequent cause of such obstructive diseases of the liver. In all of these ways blood may pass into the bowel, and be afterwards passed in the fæces.

The chief **symptom** is the passage of quantities of blood in the stools, which are in consequence usually black, like pitch. If much blood is lost, or the bleeding goes on for some time, the person will suffer in health, will be pale and weak and faint. If a large quantity be suddenly poured into the bowel, it is likely that the patient will become suddenly faint, and may become unconscious, or fall into convulsions. The cause of this may not be apparent till some time afterwards, when a large black stool is passed.

Treatment.—The various causes of bleeding from the bowels have been explained in some detail, because people are apt to think that it is sufficient to know that bleeding is occurring in order to say what remedy should be applied. Now, to take an example, it will be evident that the administration of medicines for the purpose of causing contraction of bleeding vessels, or for acting in similar ways on bleeding surfaces, will be of little use if the bleeding is from vessels distended because of some affection of the liver, some obstruction of the portal vein. Clearly, if the obstruction can be got rid of the bleeding will stop of its own accord, because the blood will get circulating, and the vessels, being no longer choked, will have no tendency to burst. Therefore, the necessity arises of determining *the cause* of the occurrence of the bleeding, a question which an unskilled person will have generally much difficulty in answering. In the end, therefore, it will be necessary for a doctor to determine what is the disease of which the bleeding is but an incident, and how it is to be treated. Till that is done, and in order to diminish the loss of blood as much as possible, the person should be kept quiet and cool, lying in bed, and should not be permitted to make any exertion. Food should be of a light sort, not warm, and given in small quantities at a time. Iced drinks in moderation may be useful, and acid drinks also. Where the bleeding was *distinctly* traceable to a loaded state of the liver, the use of purgatives to relieve the liver would be proper. The best medicines for such a purpose are a pill of ½ grain of resin of podophyllin taken at bedtime on several successive nights, or a powder of 5 grains calomel and 20 grains jalap, followed, after some hours, by a draught of some saline medicine, Epsom or seidlitz salts or citrated magnesia.

Cancer of the Bowels.—Little need here be said of this affection. The part of the intestine more liable than another to it is the lower part of the rectum.

The **symptoms** are vague and unreliable. Pain, irregularity of the bowels, discharges from them, which may contain matter or blood, &c., are among them. But these symptoms are associated with many other diseases of not nearly so fatal a character. Cancer may also narrow the tube of the bowel, and so obstruct the onward passage of the fæces.

The **treatment** is the same as that indicated for Cancer of the Stomach (p. 160).

Intestinal Worms.

There are various kinds of worms known to find a lodgment in the human body. The chief of them belong to two great classes: (1) the tape-worms or band-worms, and (2) the round or thread worms. The scientific terms for these classes are **cestodes** or **tæniæ**, and **nematodes**. Cestode is derived from a Greek word *kestos*,

meaning a band, and is therefore identical with the common word tape-worm; *tænia* is the Latin for a band or ribbon; nematode is derived from the Greek *nema*, and means a thread. There are also found occasionally in man worms belonging to the **trematode**, or *fluke* class. *Trēma* is the Greek word for an opening, and the term was applied to the worm because it exhibits suckers which were thought to be mouths. Fluke means flat, and was used to describe the worm because of its shape.

It is the object of the following paragraphs to describe the principal examples of the above classes from which human beings suffer, along with the symptoms their presence produces, and the appropriate treatment in each case. The natural history of these animals forms a most remarkable and interesting chapter of science. On this account in the description of them some small amount of detail will be given.

Tape-worms (*cestodes, tæniæ*).—There are several species of tape-worm, namely, *Tænia solium, Tænia mediocanellata, Tænia lata* or *Bothriocephalus latus*, and *Tænia echinococcus*. The two first are the commonest.

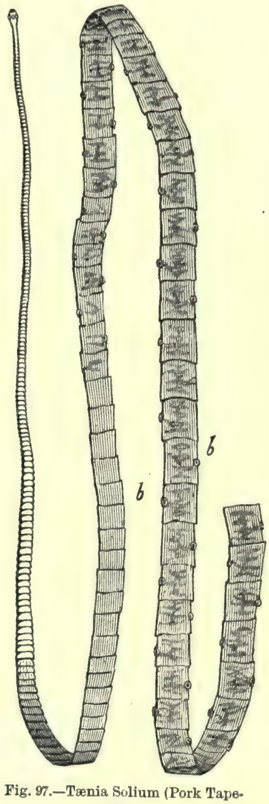


Fig. 97.—Tænia Solium (Pork Tape-worm).

The **Tænia solium** (*Pork Tape-worm*) is represented in Fig. 97. At *a* is the head, which is from the $\frac{1}{45}$th to the $\frac{1}{35}$th of an inch in diameter — about the size of a small pin head. From the head there passes a slender neck, with cross strips, which gradually becomes broader and flatter till the body is reached. The latter part of the animal consists of a series of segments or joints (*b, b*), which are shown in the figure about the natural size. The complete tape-worm measures seven to ten feet in length, and towards the lower end the joints measure about $\frac{1}{4}$ of an inch broad and $\frac{1}{2}$ an inch long. There may be as many as 1200 joints in one tape-worm. Now it must not be understood that this great length forms one individual; it consists, properly speaking, of a colony of individuals. Each fully developed joint is perfect in itself and independent, having within it the capacity for reproducing its species, and being entitled to be regarded as a distinct animal. To each joint the term *proglottis* is applied. To the long colony of proglottides which, dependent from the head, go to form the tape-worm, the term *strobilus* is applied. The head is called the *scolex*, and is to be considered as the parent of the whole colony, as will be understood immediately. It is by the scolex or head that the tape-worm is anchored to the mucous membrane of the intestine in which it dwells. A head is represented magnified in Fig. 98, 1. It has a projection or proboscis (*a*) at the extremity, which is surrounded by a double row of hooklets (*b*), there being twelve to fourteen hooklets in each row. The shape of a hooklet is represented in Fig. 98, *d*. A little above the middle of the head are four projecting suckers, three of which, *c, c, c*, are represented in the figure, by which it is aided in maintaining its hold in the intestine.

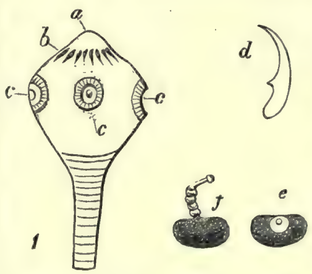


Fig. 98.—Parts of the Pork Tape-worm.

Now let us trace the history of this parasite.

It may remain in the bowel of the individual whom it infests, and who is called its *host* or *bearer*, for many years, deriving its nourishment, not by a mouth, for it has none, but by the passage through its soft body wall of some of the nourishing fluids by which it is bathed. During its lifetime it goes on shedding fully-developed joints from its extremity, while its length is maintained by the continual formation of new joints between the head and those already formed. As new joints are produced, those already formed are pushed further and further from the head, becoming developed as they pass from the head till in their turn they are separated from the rest of the strobilus and are passed by the person. The passage of the joints is a circumstance of great discomfort. A ripe joint, or proglottis, is filled with eggs, the

seed capable of producing a multitude of other tape-worms, provided suitable soil is found for them. The eggs are contained in a branched structure in the joint, indicated in Fig. 97, and one joint, it has been estimated, may contain 45,000 eggs. When a joint is passed it is still able to elongate and contract, and at length is ruptured, by means of which the eggs are liberated and scattered abroad. Each perfect egg contains a young tape-worm, but in its embryonic or larval stage, in which it has little resemblance to the fully developed worm. The embryo is only about the $\frac{1}{1250}$ of an inch in breadth, and is inclosed within a thick brownish shell, which protects it from destructive agents, the shell resisting even ordinary chemical agents. The head of the minute embryo carries three pairs of hooklets instead of the crown of hooklets of the scolex, and they are formed, not for holding on, but for boring and tearing. The eggs, then, containing such embryos are dispersed abroad. They get into sewers, into water, and in one way or another are scattered also over fields. They are liable to be swallowed by man or by animals in drinking water, and to be swallowed by animals while grazing. But man and animals in general are not suitable soil for them. This is fortunate, else how few would escape becoming a home for them. There is one animal which, *in this stage*, is suited as soil for their development, and that animal is the pig. Let a pig in its eating or drinking swallow some tape-worm eggs. In the pig's stomach the egg is dissolved and the little embryo is liberated from its case. It does not remain in the stomach, but forthwith proceeds, by means of its boring apparatus, to pierce its way through the walls of the stomach and other tissues, till it reaches a place convenient for its settling down. It may get into a blood-vessel and be thus carried to some suitable organ, liver, brain, &c., but it specially selects muscle, and, in particular, connective tissue between muscular fibres. Having reached a proper place it loses its boring apparatus and gains the circles of hooklets characteristic of the head of the perfect tape-worm, and it develops at the extremity opposite the head a small sac or bladder filled with fluid. In the living state the head and neck are coiled up in the sac (Fig. 98, *e*), but they project from the sac after death (Fig. 98, *f*). It is now called a **cysticercus cellulose**, and it has now completed its second stage, being incapable of further growth within the body of the pig. In the pig, that is to say, it remains a bladder worm and will not produce the perfect tape-worm. In the flesh of the pig it appears as a little round or oval sac, the size of a pea or even larger (Fig. 98, *f*).

Now a pig may have swallowed only a few eggs or a multitude. If the latter has been the case there will be a multitude of such cysticerci in its flesh, and the pork will have what is called a "measly" appearance. "Measles" of pork are due to these cysticerci or immature tape-worms. Now, before the cystic worm can produce a tape-worm, it must be transferred to the body of some other warm-blooded animal. Suppose a man eats a piece of "measled" pork *which has not been cooked well enough to destroy the vitality of the cysticercus*, after the piece of meat reaches the stomach the embryo is freed from its cyst by the action of the gastric juice. It thereupon attaches itself by its circle of hooklets to the mucous lining of the bowel, the tail vesicle drops off, and it becomes a scolex. Immediately behind the head minute segments are produced by a process of budding, and, in from twelve to sixteen weeks, some segments may have become quite mature and be passed as joints by the patient, at which time the tape-worm has reached its adult form.

There are thus three main stages in the development of the tape-worm.

I. The egg stage in the fully-developed joint or proglottis.

II. The stage of cysticercus, developed from the egg in the body of a pig; and

III. The tape-worm stage, produced in man by the eating of pork containing the parasite in its second stage. The joints of the fully-developed animal produce the eggs, which must escape from the body of man and gain entrance to the body of a pig to undergo development.

We have seen that it is in the pig particularly that the eggs of the tape-worm attain the second stage of their growth, and that it is specially from eating improperly cooked "measly" pork that persons are liable to get tape-worm. Yet the cysticercus stage may be developed in other animals, and it has been found, though rarely, in the muscles, brain, and eye of man. It is, nevertheless, the development in the pig that is common and worthy of remembrance. For this reason this form of tape-worm has been called the "pork tape-worm."

The **symptoms** and **treatment**, and what in some respects is of even greater importance, the **prevention** of an attack of tape-worm, will be considered when the other forms of the parasite have been described.

Tænia mediocanellata (*Beef Tape-worm*).

—This tape-worm goes through a series of wanderings and transformations precisely similar to those of *Tænia solium.* It is, however, no longer the pig but the ox or the calf that affords the most suitable soil for the development of its embryo form. Lodged in the intestinal canal of man, it gives off joints just as the former tape-worm. The joints contain eggs, which are dispersed and find their way ultimately into the stomachs of cattle, whence they work their way, by means of a boring apparatus, into the tissues of the animal and give rise to the "beef-measle." This form has, therefore, been called the beef tape-worm. If a piece of improperly cooked beef containing "measles" be eaten by a person, the embryos become free, settle in the bowel, and develop into the *Tænia mediocanellata.* But while the natural history of the parasite is similar to that of the pork tape-worm, beef or veal being substituted for pork, in its structure it differs to a considerable extent from *Tænia solium.* Viewed by the naked eye the two could not readily be distinguished. The beef tape-worm is, nevertheless, longer, being from 15 to 23, and even 30 feet long, and its joints, or proglottides are broader. The head also differs from that of *Tænia solium* in that it has no proboscis nor circle of hooklets. It has, however, four sucking discs as shown in Fig. 99, which represents the head. The absence of the hooklets is of considerable significance. We have seen that the circle of hooklets of the pork tape-worm affords a means for securely anchoring the head to the mucous membrane of the intestine. So firm is this anchorage that it constitutes one of the difficulties of treating the pork tape-worm, the medicines administered often failing to detach the head, and so long as the head remains, there is a risk of the tænia going on developing fresh joints. The beef tape-worm, having no hooklets, is less securely fastened and more easily brought away. It is commoner, therefore, to get a specimen of a *Tænia mediocanellata,* complete with head, than to get a complete *Tænia solium*, the head, in the latter case, being frequently wanting. Owing to this difference the pork-worm is often called the "armed tape-worm," and the beef-worm the "unarmed tape-worm." It was formerly supposed that the pork tape-worm was the commonest of all tape-worms, but Dr. Spencer Cobbold declares that the facts warrant him "in styling this worm [the *beef* tape-worm] the most common of all tænia liable to invade the human body." He also goes on to say "it seems strange to speak of measly beef, and yet, probably, more diseased beef exists in this country than similarly affected pork."

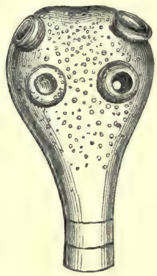


Fig. 99.—Head of Beef Tape-worm (highly magnified).

The beef measle, the cysticercus stage, that is, of the *Tænia mediocanellata*, is smaller than the pork measle—not so large as a pea—and is much more easily overlooked. The head of the embryo worm within its cyst is, however, a little larger than that of the pork-worm, but, like the head of the fully-developed parasite, it has no hooklets. A magnified view of one of the cysticerci of the ox is given in Fig. 100. It has never yet been found in man.

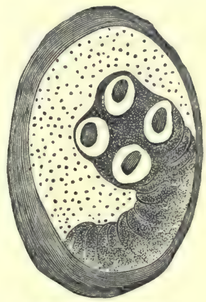


Fig. 100.—Beef Measle (Cobbold).

The beef tape-worm has been found very prevalent in the cattle of the North-west Provinces of India. This was traced in one case to the bad drinking water supplied to the cattle, sewage, containing the seeds of the tape-worm, being found in the tank from which many of the cattle were watered. The cattle belonged to the army commissariat, and if a barrack cook did not thoroughly cook the meat, tape-worm might have been given to many of the soldiers.

Bothriocephalus latus (*Broad Tape-worm*). —This variety of tape-worm is not common in England. It has been called the Irish Tape-worm, though it is commonest in the cantons of West Switzerland and their neighbourhood. It is common also in Russia, Sweden, and Poland. It was at one time very common in Geneva, but seems now comparatively rare there. This change is said by Van Beneden to be due to the fact that whereas, formerly, the water-closets were made to empty themselves into the lake, where the embryos were hatched, and so infested persons who drank of the water, now the refuse of the towns along the lake is collected for manuring the land.

The fully-developed tape-worm is of great length, more than 25 feet, and is estimated to possess as many as nearly 4000 joints. The joints, however, are not so long as those of the kinds already considered, but are much broader, and they do not separate from one another so readily as those of *Tænia solium* or *mediocan-*

ellata. The head is club-shaped, without suckers or hooklets, but having a long slit-like groove on each side. A highly-magnified view of one side of the head is given in Fig. 101. The features of this tape-worm are, then, its great length, its very numerous, short, but broad joints, which are closely packed, and its club-shaped head. Each egg is inclosed in a brownish shell, and the presence of the eggs gives to each segment a brownish-yellow colour, specially towards the *centre* of the segment, where is the aperture from which they escape. In *Tænia solium* it is to be noted this aperture is at the *side* of the segment.

Fig. 101.—Head of the Broad Tape-worm.

The natural history of the broad tape-worm is not so thoroughly known as that of the varieties already described. It seems, however, to pass through stages precisely similar to other tape-worms. That is to say, the fully-developed head, or *scolex*, throws off joints (*proglottides*) containing eggs. The eggs produce embryos which develop into the embryos with boring apparatus for tearing their way into the tissues of an appropriate host. The flesh of this host, improperly cooked and eaten, will give rise to the fully-developed tape-worm in the alimentary canal of the person who has eaten it. The embryo liberated from the egg is ciliated, that is, covered with long fine hairs. From the ciliated embryo the boring embryo is produced. In what animals these intermediary stages are realized is not known with certainty. Cobbold believes it is certain fresh-water fish, of the salmon and trout family, as suggested by a German observer, in which the embryos are developed. According to Van Beneden, however, the tape-worm passes from man to water "under the form of an egg, or of a proglottis, and from the water to man in the shape of a ciliated embryo. In this manner it is introduced with the water that is drunk."

There is still a fourth variety of tape-worm, that must be described, which is found in man, not, however, in the adult condition, but in one of the preliminary stages, the *Tænia echinococcus*, namely. It differs in so many respects from those already described that it will be better to discuss the symptoms and treatment of the latter before going on to consider it. Those that have been considered are the chief tape-worms found in the adult condition in man. There are many other varieties of tape-worm, however. Thus in the flesh of the rabbit is the cysticercus stage of a worm that attains its complete development in the dog. In the brain of sheep, infected with the disease called "gid," is an immature condition (the cause of the disease) of the tænia of the wolf. The tænia that infests the cat has previously lodged in the mouse or rat. Almost all birds nourish large tæniæ. "Woodcocks and snipe always have their intestines stuffed full of tænia and the eggs of these worms. Every bird contains them by thousands. Fortunately we cannot be infested with the tænia of the snipe and the woodcock."

The **symptoms of tape-worm.**—The usual symptoms that give rise to a suspicion of the presence of worms in the intestinal canal are, colicky pains and irregularity of the bowels, picking of the nose, grinding of the teeth during sleep, bad or capricious and sometimes voracious appetite, increasing thinness of body, foulness of breath, itching of rectum and fundament, sickness, dizziness, headache, nervous irritability, and a tendency to faintness, &c. Yet worms may be present without any of these signs manifesting themselves. On the other hand, the presence of worms may give rise to other symptoms of a very serious kind which yet do not in any way indicate their cause. For example, the irritation of worms may produce convulsions or attacks of St. Vitus' Dance, specially in children, and may occasion hysterical attacks in women. Cases are on record of tape-worm producing insanity, epilepsy, paralysis, blindness, and squint.

There are no special symptoms associated with the presence of the cysticercus stage in the human body.

In all cases the only conclusive sign of worms is the passage of a worm, or parts of one, in the fæces, which ought in all suspected cases to be carefully scrutinized.

The **treatment of tape-worm** is happily not difficult, is perfectly safe, and usually successful. The drug now most esteemed is the male-fern root, of which both powder and extract may be used, but the extract is preferred. Half a tea-spoonful to one tea-spoonful and a half (according to age) of the liquid extract should be given, made up with a little syrup of ginger and water. It acts best when taken early in the morning, only liquid nourishment having been taken the previous day. This secures that the tape-worm is not protected from the drug

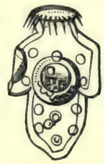
by masses of food stuffs. Four hours after the medicine a strong dose of castor-oil will aid in bringing away the worm. The powders of kousso and kamala are also admirable for destroying tape-worms. Of either of them 60 to 180 grains are given, made up with honey or syrup, early in the morning, and are followed, after some hours, by a purgative dose of castor-oil. In the absence of any of these medicines oil of turpentine may be employed, 1 to 3 tea-spoonfuls being given with 4 tea-spoonfuls of castor-oil, also early in the morning.

The stools that are passed after the administration of the medicine ought to be carefully scrutinized, not only for joints of the tape-worm, but for its whole length, and specially for its minute head. As has been already mentioned, the *Tænia solium* is firmly secured to the mucous membrane of the bowel by its crown of hooklets. It is more difficult, consequently, to remove it than the head of other kinds. Since it is from the head that the production of joints occurs by budding, one's security is greatest if the head has been detached and voided in the stools.

Tænia echinococcus (*Hydatid*) is a form of tape-worm whose adult condition is found in the dog and wolf, but which may exist in the human body in a larval or immature condition, in which state it forms cysts or sacs, filled with fluid (hydatid cysts), and of various sizes in various organs of the body, but specially in the liver. "Where dogs are not kept it is well-nigh impossible that the disease should be contracted." The disease is very common in Iceland, where, at one time, it was estimated there were as many as 10,000 people suffering from it. "The fact that every Icelandic peasant possesses on an average six dogs, and that these dogs share the same dwelling (eating off the same plates and enjoying many other privileges of intimate relationship) sufficiently explains the frequency of hydatids in that country." In English dogs the presence of the tape-worm is comparatively rare. In Australia the hydatid disease is also very common, being very prevalent in Victoria. A magnified view of the fully-developed tænia, as found in the dog or wolf, is shown in Fig. 102. It is very much smaller than the other tæniæ that have been described, measuring only $\frac{1}{4}$th of an inch in length. It contains only four segments. One segment forms the head, which has a pointed

Fig. 102.—Tænia echinococcus (Cobbold).

extremity, a double crown of hooklets, numbering thirty to forty, and four suckers. The last segment is as long as the other three put together, and contains the eggs. The eggs, set free from a dog, may gain access to water, and thus, in drink or in other ways, may be introduced into the body. The eggs are acted on in the stomach, and from them are liberated embryos with six boring hooks, which work their way into the blood-vessels of the person, and are thus distributed throughout the body. Having arrived in a suitable organ the embryo undergoes changes by which it becomes converted into the hydatid cyst, in which form it is found in man. The cyst is a sac of varying size, at first small, the size of a nut or less, but capable of growing to a size equal to that of a child's head. The cyst is filled with granular and fluid



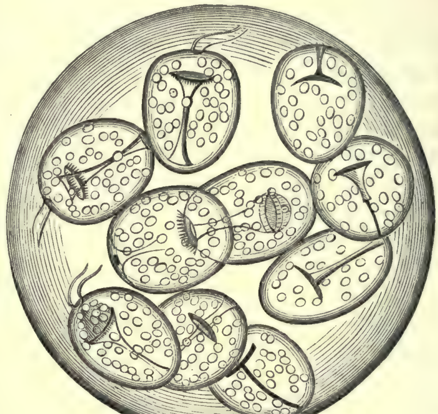


Fig. 103.—Hydatid Cyst.

contents. From the walls of this sac others grow bud-like. These are called "brood capsules," because it is within them that the second stage of the *Tænia echinococcus* is developed. The contents of a brood capsule become converted into an echinococcus head, which is about the $\frac{1}{120}$th to $\frac{1}{200}$th of an inch in length and of an egg shape. The head has a proboscis with a double circle of hooklets, and there is a constriction in the middle of the small structure which divides the extremity with the head from the other. Fig. 103 shows a cyst with brood cap-

sules in its interior, and above this figure is represented one of the echinococcus heads as removed from its capsule.

Symptoms.—It is scarcely necessary to enter into the question of the symptoms of hydatid cyst. It usually affects the liver, and manifests itself as a swelling which gradually enlarges so as to cause a projection of some part of the belly. It may occasion symptoms of dyspepsia, or, by pressing on and obstructing the bile-ducts, produce jaundice, or by pressing on blood-vessels cause dropsy, piles, &c.

Treatment.—No medicine can destroy the hydatid nor arrest its growth. What can be done is to puncture the tumour and draw off the fluid by means of a fine tube. This of course is a question and procedure for a surgeon. If an examination of the fluid by the microscope shows the presence of hooklets (as shown in Fig. 98, *d*, p. 168), which have been detached from the echinococcus heads, the nature of the tumour is evident.

The Prevention of Tape-worm.—The prevention of hydatid may be disposed of first. It has been noted that the seeds of the parasite are obtained from the dog, and that where dogs are not kept "it is well-nigh impossible that the disease should be contracted." Where dogs are kept, care and cleanliness should remove all risk of disease. A dog affected with tape-worm should receive physic at intervals. Dr. Cobbold advises that its excreta should be burned, and that boiling hot water should occasionally be thrown over the floors of all kennels where dogs are kept. The eggs are destroyed by the heat of boiling water. If there is any risk of them getting into drinking water it should be boiled before use. To improve its taste afterwards it should be shaken up with air. Careful filtering through a charcoal filter will keep back the seeds. The filter should not be used too long without heating, to destroy ova that have been retained by it.

The prevention of other forms of tape-worm may also be secured by care and cleanliness. As we have seen, the common tape-worms are derived from measled beef or pork, and if one eats no measled beef or pork no danger is incurred. But one cannot always be sure that no measles exist in the meat one is eating, and it is of the utmost consequence to know whether there is any method of securing that any bladder or cyst worm that meat may contain is destroyed before it is eaten, so that it becomes unable to produce the mature tape-worm. There is such a method, and it is by heat. The cysticercus of the beef or pork tape-worm cannot survive a temperature of 140° Fahr. continued for five minutes. That temperature is considerably below the boiling point (212° Fahr.). This has been made quite certain by the experiments of an Italian, Dr. Perroncito, who submitted the cysts to various temperatures, and who found them die when they were heated up to 120° or 130° Fahr. His results were proved by some students, who, of their own free-will, swallowed some so heated, but were never affected with tape-worm.

A sufficient degree of heat, then, kills the measles of veal, beef, or pork. It is, therefore, certain that meat properly and thoroughly cooked cannot occasion tape-worm. It must be noticed that to destroy measles in meat the meat must be heated through and through to the proper temperature. The outside of the meat might be heated sufficiently, but the inside not nearly enough, so that measles in the deep parts would escape. This ought, therefore, to be watched in the cooking of any large piece of meat. Minced meat and sausages ought to receive special attention.

Another danger must be avoided. A cook who has cut up meat containing measles may harbour them on her hands. She may cook the meat properly enough, but in serving it up, if she has not previously washed her hands, may introduce the parasite on to the plates; or if a cook uses the knife, with which the uncooked meat has been cut up, to serve the food up for dinner, without cleaning it properly, the cystic worm may be conveyed to the cooked food.

It seems that measles in cattle have no very long term of existence. Dr. Cobbold has shown that an animal with measles is cured naturally, by the death of the parasites, after the lapse of ten months. Beyond that term the cysticerci do not live; they die and are subject to chalk-like degeneration. Cattle known to be measled should, therefore, be sent to some place where there is no chance of them getting a fresh infection, and should be kept there for eight to ten months. At the end of that time, if they have not meanwhile received a fresh supply, it would not be possible for their flesh to produce tape-worm, even though it were undercooked before being eaten.

Thus cleanliness in every respect, and thorough cooking of all meat, are effectual preventives of the occurrence of tape-worm.

II. **Round-worms** (*Nematodes*) are different in

appearance from tape-worms. They are not flat like the latter, but present characters resembling earth-worms, having elongated round bodies marked with cross ridges. They have a mouth at one end, an anus near the other extremity, and an alimentary canal connecting the two. They offer this great distinction to the tape-worms, that the sexes are separate, the male being smaller than the female. Their natural history is not so well known as that of the tape-worms. It seems certain, however, that they have several stages of existence like the tape-worms, and that these different stages are passed in different "hosts" or "carriers." It seems evident that they cannot grow and multiply in the intestinal canal of man. The seeds, which a female will discharge in a day, number many thousands, and, if it were possible for their eggs to be hatched in the intestinal canal of man, the number of worms of which he might be the victim would be beyond estimating, and would produce symptoms such as are never experienced. It appears, therefore, that the ova or seed must be expelled from man's intestinal canal, must develop in some other place or animal, and must return to man in a more advanced stage in drinking water, along with food or flesh, or in some other way, before the mature animal can be produced. Where these secondary stages are produced is not known.

Fig. 104.—The Common Round-worm.

The Common Round-worm (*Ascaris lumbricoides*) is shown in Fig. 104, and resembles in appearance the common earth-worm. The females measure from 10 to 14 inches in length, and from $\frac{1}{4}$ to $\frac{1}{5}$ inch in thickness, while the males are 4 to 6 inches long and correspondingly narrower. The female produces eggs about the $\frac{1}{340}$ to $\frac{1}{440}$ inch in size to the number of 160,000 daily. The eggs are contained within a shell and pass out in the fæces. It would seem that the round-worm of man and that which infests the hog are the same, and that perhaps the hog is the animal in which some stage of the parasite is accomplished.

Impure drinking water may be a source of infection.

Usually only six or eight of the worms inhabit the intestinal canal, though cases are on record of one person harbouring a multitude.

It is the upper and middle part of the small intestine that the worm frequents, though it may wander upwards or downwards.

Symptoms.—Persons may harbour worms and yet manifest no indications of their presence. But symptoms of intestinal irritation may arise, such as colicky pains, sickness and vomiting, looseness of bowels, itching of the nose and anus. Convulsions in children are not infrequently caused by the irritation of worms. Epilepsy has been produced by them, and various other nervous diseases.

Treatment.—Santonin, the active principle of santonica, is the best remedy. It is given in doses of from 1 to 3 grains for a child, and twice as much for an adult. It should be given in the morning in cream, and followed an hour or two afterwards by a dose of castor-oil.

Common Thread-worm (*Oxyuris vermicularis, Seat-worm*).—This is specially the worm which plagues children. It is shown in Fig. 105, the female (*a*) and male (*b*), magnified considerably. The female is from $\frac{1}{3}$ to $\frac{1}{2}$ inch long, and the male about half that size. They occur in the large intestine, specially low down. They are often present in very large numbers, and may be passed in ball-like masses coiled up with one another. In females they may pass out of the anus and into the vagina, setting up irritation there, inducing itching, excitement, and discharge.

Fig. 105.—The Common Thread-worm.

It appears that this worm may pass through its various changes of development in the same host. But the eggs, it seems, cannot be hatched in the lower bowel. A person, however, troubled with these worms may infect himself by the accidental conveyance of the eggs from the anus to the mouth. By scratching, the person may catch up eggs under the finger nails, the eggs pass into the stomach, and the action of the gastric juice enables the hatching to take place.

The **symptoms** are those of irritation, itching of the anus and nose, restlessness, and nervousness. They are worse at night. Children grind their teeth, toss off the clothes, &c., and, as with the round-worms, may be attacked with convulsions. The appetite is often excessive and the bowels irregular.

Treatment.—Santonin, 1 to 3 grains, along with $\frac{1}{4}$ grain of podophyllin is given to drive the worms down as far as possible. After that, repeated injections of warm water to which salt is added bring them away. Injections of water with infusion of quassia may also be used. The patient should also get good food, vegetables being avoided, and should have a course of quinine and iron tonic.

The Whip-worm (*Trichocephalus Dispar*) is more common on the Continent than in Great Britain. It abounds in Italy, Egypt, and the United States of America.

The female is about 2 inches long, and the male $1\frac{1}{2}$ inch. The worm has a thick rounded body ending in a fine thread-like tail, which is about two-thirds of the entire length of the animal.

Symptoms of its presence seem to be absent as a rule. Its presence may be discovered by the detection by the microscope of the eggs.

Treatment is the same as for the round-worm.

Dochmius duodenalis (*Sclerostoma duodenale*) is the name of a worm common in Egypt and Northern Italy. It measures nearly $\frac{1}{2}$ inch long. They attach themselves to the lining membrane of the upper part of the small intestine, and suck the blood of their victims. They thus produce bloodlessness in the person, and occasion the disease called chlorosis, or green-sickness, caused by loss of blood. They may kill in this way. They were the cause of a serious fatality among the labourers at work on the St. Gothard Tunnel.

The **treatment** consists in giving extract of male-fern, as advised for tape-worm (p. 171).

Trichina spiralis (*The Flesh-worm or Spiral Thread-worm, Trichinosis*).—This is a worm to which man and flesh-eating animals are liable. It is shown in Fig. 106, highly magnified, where it is seen to be coiled up in a lemon-shaped cyst. The worm is very small, the male measuring $\frac{1}{18}$th inch, and the female $\frac{1}{8}$ inch. They inhabit the voluntary muscles of the body, and to the naked eye appear in their cysts as minute white specks. The specks are gritty, because of particles of lime that get deposited in the walls of the cyst. The history of the parasite is as follows:—Man is infected with them from eating the flesh of some animal containing them. The pig especially is the source of infection, but they are capable of living in other animals, cats, dogs, rabbits, calves, &c. A person having eaten improperly cooked meat containing the Trichinæ, the capsules are dissolved by the gastric juice, and the worm freed. It develops rapidly, becomes mature on the second day, produces eggs which, while still within the womb of the mother, develop embryos. The embryos escape into the intestinal canal of the host after the sixth day and proceed to wander. They eat their way through the intestinal walls and migrate through the body. Gaining entrance to blood-vessels, they are carried to every organ. They seek the muscles, into which they pass and settle down among the connective tissues between the fibres. They have reached their destination in about fourteen days. In its place the worm becomes coiled up, and in time a cyst is formed round it. One pig infected with Trichinæ may contain as many as sixteen millions, and yet may never display any symptoms of irritation. In man, however, serious symptoms arise, and death often results.

Fig. 106.—Trichina spiralis.

Symptoms.—Within a day or two after eating the infected meat the person suffers from thirst, loss of appetite, irregularity of bowels, perhaps diarrhœa, pains and uneasiness in the belly; in short, there are signs of intestinal irritation. There are also some fever and quickened pulse. Later, when the person may be recovering from these symptoms, and at the time when the young animals pursue their wanderings, there are rheumatic-like pains in the limbs, only it is the muscles, not the joints, that are affected, and the pain is accompanied by swelling. The limbs become stiff and cramped, and dropsy of the face appears and soon becomes general. The fever increases, and may become excessive. Death may result early from inflammation of the bowel or of the abdominal cavity, or may occur later from exhaustion. The disease lasts from a month to three or four months.

Treatment.—No treatment will destroy the worms after their wanderings have begun. All that can be done then is to support the patient's strength. If a person suspects he has swallowed diseased pork, he may ward off the attack by the use of purgatives and the use of such remedies as have been recommended for tape-worm. This must be done early before the young can be hatched.

But of great consequence is the fact that the disease due to Trichina, called trichinosis, may be prevented by care in the use of pork, sausages, ham, &c., and by thorough cooking of

such flesh. Trichinosis is very common in Germany, attributable to the fact that the people eat a great deal of only half-cooked, and indeed nearly raw, ham.

Indigestion, Hiccup, Colic.

Indigestion (*Dyspepsia*).—Dyspepsia is really a Greek word, and means bad digestion, or difficult digestion. Indigestion means essentially the same thing. Now the words indigestion and dyspepsia refer to a condition of digestion, but that condition, bad or difficult digestion, may arise from a great multitude of causes. A person might suffer to-day from indigestion due to one cause, and might next week suffer again from indigestion from a cause so different as to make totally different treatment necessary, so that practically the two kinds of indigestion from which the person suffered might as well be considered two different diseases. The term indigestion, or the term dyspepsia, is thus used to cover a great number of diseases, which have this much, and perhaps only this, in common, that, owing to them, the food is not digested properly, in good time, or in comfort, and thus the main symptom arises from which the disease is named—some feeling of discomfort or actual pain connected with the presence of food in the stomach and bowels. Now it is essential that this should be properly understood. Very many people go to a doctor and announce to him that they are troubled with indigestion, and expect that, without more ado, he will order them a medicine that will remedy, without delay, their complaint. If he begins to make inquiries they answer impatiently: "Oh! I know very well what is wrong; it is just indigestion." In the same way people will turn up some dictionary of medicine and expect to find, under the head "Indigestion," some definite statement of treatment, which they have only implicitly to follow to be healed of their plague. Now such a view of the practice of medicine is an utterly mistaken one, and perhaps no disease shows how mistaken it is than this one. If reference be made to what has been detailed in pages 142 to 145 about the process of digestion, it will be noticed that there are various stages in the process: that one part of the process is performed in the mouth, another part in the stomach, a third part in the bowel; that the part performed in the mouth consists of (1) chewing, and (2) the action of saliva on the starchy parts of the food, that in the stomach of (3) the action of gastric juice on albuminous parts of the food, that in the bowel of (4) the action of bile on fat, (5) the action of pancreatic juice on starch, albumen, and fat, and (6) the action of intestinal juice on various elements of the food. Now if any of these stages be imperfectly performed the whole process may be interfered with. In a piece of machinery the stiffness or irregularity of one small wheel may affect the working of the whole machine. No one would go to an engineer and say: "My engine works badly," or "My engine works with difficulty," and then expect to be told that the doing of some particular thing would make it right. Everyone knows the engineer would carefully examine till he found the exact place where the difficulty was, and then he would be in a position to say what would rectify it. Let us look at digestion in that light. If a person eats hurriedly, bolts his food, the first part of the process (chewing) is not properly performed. The result is that the food passes in masses into the stomach, and not broken down into very small pieces. The juice of the stomach gets acting only on the outside of the lumps of food, cannot get intimately mixed with it, cannot attack much at a time, and so the process is delayed; perhaps twice the time is occupied that there would have been if the person had taken the time and trouble properly to break down the food in the mouth before passing it on to the stomach. Suppose, however, the food is properly chewed, when it reaches the stomach, owing, perhaps, to the general health of the individual, sufficient gastric juice may not be poured out, or there may be always enough in quantity, but of poor quality. The juice may contain too much acid, or too little acid (p. 144), or may be not active enough with pepsin (p. 143), and in various other ways this stage of the process may be badly performed. Again, everything may be properly performed in the mouth and in the stomach; but when the food reaches the small intestine, bile (p. 145) may be deficient owing to some fault of the liver, and the digestion of fat is interfered with; or the pancreatic juice (p. 145) may not rightly discharge its duty, and so digestion, which up to this point had gone on properly, is arrested, or in some way interfered with, and indigestion arises. But this is not all. We know that engineers never build engines without having first decided what power they wish them to develop, at what speed they are to drive a boat or a train, what load they must be able to draw or to lift. It is but common sense to suppose that the human digestive apparatus is

constructed, so to speak, for a certain power, that there is a certain quantity of material which suits it best, and that if it has to digest a quantity greatly in excess of that it will be overstrained or overloaded, and again indigestion may result. But it is equally common sense to suppose that, like machines invented by man, the digestive apparatus of a human being is adapted not only for a certain *quantity* of work, but also for a certain *kind* of work. The digestive apparatus of a worm is suited for the earthy food from which it draws its nourishment; and the apparatus of an ox is different, because its feeding is different. So there are certain kinds of food appropriate for man which his stomach and bowels, in their healthy condition, find natural to them, and certain other substances which they tend to reject as offensive to them. Now, knowing these things —and many other circumstances have a similar bearing on the subject—knowing these things, is it not perfectly absurd to imagine that there can be one cure for indigestion, that the bare fact of a person suffering from indigestion is sufficient to indicate what treatment should be adopted? And is it not apparent that there may be as many ways of treatment as there are causes of the complaint, and that the only rational course to take is to ask what is the exact nature of the indigestion—does it arise from improper food, or from too much or too little food? is it due to too hurried eating? is the seat of indigestion in the stomach or in the bowels? and so on—and to let the treatment be guided by the results of such patient and careful inquiry? In short, is it not plain that the cure for the indigestion that afflicts a person whose bad teeth, or whose want of teeth, prevent him properly chewing his food, is quite different from the treatment that will cure the indigestion of another whose teeth are perfect, and who chews his food well, but whose liver is sluggish, and so hinders the digestive process. Probably a slight stimulant to the slow liver, such as podophyllin, will help the latter individual, but is worse than useless to the former, whose indigestion will probably be driven away by a properly constructed set of false teeth. The truth that these considerations ought to enforce is the necessity of determining, as accurately as possible, the stage of the digestive process that is interfered with, and the cause of the interference whose result is indigestion, before steps are taken to rectify what is wrong; and this truth, the need of discovering the cause, is as applicable to every other disease, and for similar reasons.

What the causes of indigestion are may now be briefly set down.

Causes of indigestion.—These may be divided into three classes:—I. causes connected with the taking of food; II. causes connected with the process and organs of digestion; and III. causes connected with other organs, or with general conditions of the body.

I. Under the first class come many causes, some of which have been already incidentally noted. They are connected with the quantity of food, the quality of food, the length of time between meals, the length of time taken to meals. Many people believe that almost everyone regularly eats more than is necessary. However that may be, it is certain that many people habitually over-eat, and that the fashionable style of dining tempts one to excess. For it is certain that when one partakes of a great variety of dishes, taking small quantities of each, the appetite is stimulated and maintained long past the time when satisfaction should have been felt. No absolute rule can be laid down except this, that the food that is necessary is just the quantity that will repair the waste of the body, and minister to any processes of growth that may be going on. Consequently, the hard-working man requires more than the man of idleness or ease. [In the chapters on Food details on this subject are entered into.] As an ordinary rule, satisfaction indicates that sufficient has been consumed. As regards quality of food, enough for the present purpose has been said on pages 132 to 134. But it ought to be evident that tea and bread and butter, which seem to constitute the never-ending, unvarying diet of very many working-men, their wives, and children, is not a proper kind of diet. From a very considerable experience the writer can say that a very large proportion of diseases, beginning with indigestion and leading on to others, which are common among the working-classes, is due to improper diet such as has been mentioned. The question has, of course, another side. The quality of food may be improper because it is too rich, or the food may be in itself very difficult of digestion. Thus foods rich in fats are likely to be indigestible, and the flesh of most shell-fish, lobster, &c., is difficult of digestion. A fish supper, in which oysters, lobsters, or crabs form a part, is not unlikely to lead to an uncomfortable night, and various digestive troubles—headache, loss of appetite, &c.—next day. Many people are peculiar in having an aversion to certain ordinary articles of diet which agree well with others,

but are certain to cause them trouble if taken. Tea, coffee, and alcohol are very apt to cause indigestion. Recent observations made by a French physiologist seem to show that the active principle of tea and coffee seriously delays the digestion of a meal with which it is given. At least the constant use of tea is bad, and specially if it is not freshly prepared, and if it is made very strong, as it frequently is. As to alcohol, no doubt small quantities used during a meal are in many cases a stimulant to sluggish digestion, but this fact is too often used as an excuse. It is the rule that the habitual use of alcohol, even in nips, leads to chronic catarrh of the stomach (p. 158), and to degenerative conditions of the liver, both extremely common causes of most intractable forms of indigestion. With many people tobacco directly provokes dyspepsia. The times of meals are of very great importance. We have seen (p. 144) that after an ordinary meal the stomach will be occupied with its business for three to four hours. If only that interval elapses between several meals, the stomach has no rest between meals, but is no sooner done with digesting one than it is required to attack another. A short time should, therefore, be given between each meal, in which the stomach may renew its energies. Thus an interval of five or six hours should elapse between two meals. On the other hand, too long an interval is hurtful, and specially when, as is usual, the long fast is followed by a heavy meal. This is the error to which business men are liable. Nothing, or a quite insufficient quantity, is taken between the time when they breakfast and the time, usually late in the afternoon, when, business over, they return home. They then dine, and the temptation to forget the worries of business in the pleasures of eating and drinking is great, and leads them to prolong the time at table, and to stimulate the appetite with variety—with sauces, condiments, &c. Not only is this hurtful, from the excess to which it tends, but the stomach is probably not in a good condition for digesting even an ordinary meal, because of the degree of tiredness and of exhaustion, greater or less, that is the result of the day's work. Properly the business man should have a mid-day meal sufficient to maintain his energies, but light enough to ensure that it does not render him less fit for business, and when he returns home let him dine, but more sparingly, so that the remainder of the evening is not spent in a dull, half-asleep fashion, the result of a heavy meal, taken after an exhausting day of work without timely nourishment.

Again, the first class of causes of indigestion includes such errors as that of eating too hastily, taking food immediately after great exertion, or performing hard work, engaging in mental toil, or taking vigorous exercise, immediately after meals. As a cause of indigestion, also belonging to this class, must be included mental emotion, such as anxiety, alarm, or the emotions roused by the receipt of bad news, &c. In most cases, perhaps, the latter cannot be remedied; but, as regards the former, it should be a rule to rest a short time after hard work before partaking of food, and to occupy one's self with light employment for a short time, half-an-hour or an hour, after a full meal.

II. The second class of causes includes circumstances, many of which have been already noticed. Imperfect chewing, either because the food is bolted, or because the teeth are bad or wanting, is one rather common cause of this class. Others are connected with the state of the stomach and the character of its digestive fluid. Thus, catarrh of the stomach, the result of a common cold, causes loss of appetite, &c., and most of the other diseases of the stomach act similarly. Acidity and heartburn, common symptoms of dyspepsia, arise from excess of acid; and so on. Similarly conditions of the bowel, of the liver, and of the pancreas, all parts of the digestive apparatus, will act as causes of indigestion.

III. The third class includes a great variety of conditions which affect the process of digestion directly or indirectly. Thus anæmia (bloodlessness) is in women a very common cause of dyspepsia, because the blood is not in proper condition to afford to the stomach the material for the formation of gastric juice in proper quantity and of proper quality, and because other parts of the digestive process are similarly affected. Diseases of the heart and lungs, by hindering the proper circulation of the blood, speedily affect the functions of the stomach and bowels. The nervous system regulates every function of the body, and consequently nervous diseases have some kind of dyspepsia as one of their symptoms. Properly speaking, in such cases the indigestion is not a disease in itself; it is only a symptom of a disease. In many, however, it may be so prominent a symptom as to blind to the fact that it is really only a sign of some other derangement which must be discovered.

It is worthy of special notice that in women

dyspepsia is a very common result of tight lacing, because the pressure does not permit the healthy action of the liver, and induces other changes in the abdominal organs, of which the indigestion is one of the early expressions.

Forms of indigestion, with their common symptoms.—From what has been said, the explanation of the commonness of dyspepsia and the difficulty of its satisfactory treatment will be evident. For the similarity of dyspeptic symptoms, no matter from what cause the affection has arisen, renders it very difficult to discover the exact reason for their presence. The infinite variety of causes and of symptoms is only equalled by the infinite variety of drugs recommended for them. It is the commonest possible experience that the medicine that cures one man is totally valueless for the indigestion of another, though the symptoms be identical. This is probably because, though the signs are the same in both cases, the conditions are not, though what the difference is might puzzle the most skilful physician to discover. Hence there is a temptation to try one drug after another in the hope of sooner or later hitting on the proper remedy in the particular case. For it is more often "luck than good guidance" that happens on the cure. Yet this is not a proper or satisfactory method. What, therefore, will be attempted here is to distinguish between various types or forms of indigestion, and to note their commoner and more pronounced symptoms, in the hope that this will aid in determining what is likely to be the kind of treatment that will be efficacious. It must be remembered, however, that it is merely types that will be noted, and that no hard-and-fast distinctions are sought to be drawn.

(1.) **Slow Digestion** is a very common form of indigestion. Its usual symptoms are a sense of weight and fulness after taking food. It is accompanied by costiveness. There are also coated tongue, a bad taste in the mouth, flatulence, and, accompanying occasional discharges of wind from the mouth, there are small quantities of sour material. The failure to digest speedily, and the accompanying constipation, induce a tendency to headache, and a feeling of dulness, mental depression, and disinclination for exertion.

Now very often such a condition of affairs is induced simply by want of proper regulation of times of eating, and of quantity of food, by want of exercise, and so on. In such cases the liver is sluggish. It may be this was the immediate cause of the indigestion, but in any case it tends to maintain and aggravate it. In other cases the indigestion is what is termed *atonic*, that is, due to want of tone. There is lack of energy in the stomach, deficient secretion of gastric juice, or lack of power in the juice to perform its work. This want of tone in the stomach may be simply part of a general condition of body, that general condition, for instance, termed anæmia, in which the sufferer is pale and wants the ruddy look of health.

Its treatment proceeds on very simple lines. Let food be taken at regular intervals of five hours or so, let it be light and easily digestible, fatty food, pastries, and highly-spiced dishes being avoided. In fact the simpler the diet the better. Let regular exercise be taken. If the person is in a position to have horse exercise nothing can be better. Next the constipation must be got rid of. For this an excellent remedy is the resin of podophyllin (⅛th grain), the extract of nux vomica (⅛th grain), and the extract of gentian (1 grain) made into a pill. One such pill should be taken every morning before breakfast. As a rule it produces no discomfort. It gently stimulates the liver and procures an ordinary movement of the bowels sometime during the day. Instead of this a pill containing 5 grains of rhubarb and 1 grain ipecacuanha powder may be used. In either case the pill should be continued for ten days or longer. It cannot, however, be too often repeated that there is no use giving such pills if bad habits of dieting are maintained.

In the atonic form of dyspepsia dilute hydrochloric acid is extremely valuable. It should be given in doses of from 5 to 10 drops in a little water, *always immediately after meals.* In many cases not acid but alkaline treatment is best, but the *alkali must be given before meals.* The best alkaline medicine for the purpose is the bicarbonate of soda, in doses of 8 to 15 grains. Bitter tonics are also prescribed, such as tincture of gentian root, chiretta, &c., which may be given with the soda. (See PRESCRIPTIONS—BITTER TONICS.) In cases of general weakness preparations of iron are used with tonics, for example quinine and iron tonic, &c. (Refer for this also to TONICS.)

(2.) **Indigestion from Catarrhal Conditions of the Stomach or Bowels.**—This may be put more plainly by saying that the dyspepsia is due to some irritation of the stomach or bowels. The irritation may be temporary, in which case the indigestion is likely to be short-lived, and perhaps severe. But if the irritation be chronic the indigestion is of a most intrac-

table sort, indeed, as long-lived as the irritation. The presence of the irritation produces such a condition of the intestinal wall as has been noted as occasioning GASTRITIS (see p. 157). In such a case there is loss of appetite, a bitter taste in the mouth, coated tongue, and specially sickness and vomiting, the vomiting, it is to be observed, coming on very soon after a meal. Indeed almost a certain sign of irritability of the stomach is vomiting speedily after food, even when only small quantities have been taken, vomiting not only of food but of a glairy mucus, secreted from the mucous wall of the stomach. If the vomiting be frequent or severe it is likely soon to be tinged with bile, and so people say it is a bilious attack. This is as likely as not a mistake. It is the frequent efforts of vomiting that force up some of the bile out of the small intestine into the stomach, from which it is afterwards expelled. It is the vomiting that causes the bile in the stomach, not the bile that causes the vomiting. Of course the irritation may not be so great as to make the symptoms marked, and they are more or less modified, and accompanied frequently by belching up (**eructation**, as it is called) of badly smelling gases, when the bowel shares in the irritation. Looseness of the bowels with colicky pain is present. Now an irritable condition of the stomach may be caused by swallowing food hastily, without proper chewing. The remedy is evident, and if it is the want of teeth that caused the food to be swallowed in masses, let false teeth be properly fitted. It may be improper food that has created the disturbance. In this connection it is to be noted that some people are affected by certain quite ordinary foods as if they were irritant poisons. Some people cannot take mutton without sickness and vomiting setting in. Even milk has been known to act similarly. With many people a boiled egg produces nausea, depression, and diarrhœa. A common cold, ending in gastric catarrh (p. 158) will produce this kind of indigestion. But nothing so readily induces the catarrhal condition with its attendant irritability as excess in alcohol.

The **treatment** of this form consists first of all in avoiding all substances that are likely to set up or continue the irritable condition of the digestive organs. Let the tippler not delude himself into the belief that just because of his troublesome stomach he needs an occasional nip to keep him up; and let others take ordinary precautions not to take what manifestly disagrees with them. Secondly, nothing has such a marked effect on an irritable stomach as careful regulation of the *quantity* of food taken. If a person is troubled with constant vomiting of food, let the quantity of food be gradually reduced till the amount is found which the stomach retains. Provided it is not some serious mischief that is at the bottom of the disorder, this method is almost certain to be successful, if properly pursued. If it is a very small amount that is retained, let it be repeated at short intervals, and let the quantity be gradually increased and the intervals lengthened until the natural condition is restored. A short attack of irritability of the stomach and bowels will be wonderfully allayed by sips of iced milk, or by the sucking of small pieces of ice. The powder of ipecacuanha is a favourite remedy for such cases in ½-grain doses. The cases of chronic irritation—chronic catarrhal conditions—are, however, extremely difficult to treat, and a great many remedies have been tried. A valuable remedy is bismuth. Trousseau, the French physician, advises it in large doses along with precipitated chalk, at least 10 grains of each being taken together before each meal. Failing this, acids may be tried—dilute hydrochloric acid taken in 10-drop doses in water at the end of each meal. Effervescing draughts are also useful, and much benefit has often been derived from such an effervescing draught as Eno's Fruit Salt affords, taken early every morning.

(3.) **Acid Indigestion** is marked by an excessive secretion of very acid juice. Severe heartburn is common in this form of the complaint, and every now and again a small quantity of the acid material comes up with eructation, seeming to burn all the way up, till all down the gullet feels raw and fiery, and even the teeth are set on edge. This may go on for hours, and be accompanied by a sense of fulness as if the food were unable to escape from the stomach. The acidity is often accompanied by flatulence.

Treatment.—Again it must be insisted on that the person regulates his food with care. The bowels should also receive attention, and, if necessary, a saline draught should be taken in early morning. Eno's Fruit Salt or similar medicine will do, or a wine-glassful of a mineral water like Hunyadi Janos. Now it is certain that often nothing relieves this condition like an antacid (a substance opposed to an acid) such as soda or magnesia, of which half a tea-spoonful may be taken in water. A tea-spoonful of seidlitz salt dissolved alone in water is

useful, and helps also to relieve the bowels. The subnitrate of bismuth, 10 to 15 grains, a quantity that can easily be picked up on a sixpence, is also advised. It is, however, frequently the case that acidity is best treated by other than alkaline remedies, apparently because medicines like soda, &c., stimulate, by their opposition, an increased secretion of acid. Thus acid indigestion yields most readily in many cases to acid treatment, but the acid (10 drops of dilute hydrochloric acid in water) must be given *a short time before each meal.* When given at this time it checks the excessive secretion of acid and prevents the development of acid by fermentive changes in the stomach.

(4.) **Flatulent Indigestion** is characterized by the formation of gases in great quantity in the stomach and bowels. The gas is supposed to be produced by decomposition of the food. The gases may have a very bad odour. Their presence is indicated by fulness, distention, and pain, and their movements through the bowels are attended by gurgling noises. Flatulence is often accompanied by acidity.

Treatment.—In very many cases confirmed flatulent indigestion is due to nothing else than bad regulation of diet, to too long intervals between meals, and to the too frequent use of tea. Let these errors be first of all corrected. Where the flatulence is the main symptom and the gases appear to be developed by fermentation, charcoal is the best remedy. It should be taken either soon before or immediately after food, according as the wind is developed immediately on eating or some time after. The dose is 5 to 10 grains of wood charcoal. In other cases where the flatulence is only one of other general dyspeptic symptoms, an acid with some vegetable tonic is valuable. (See PRESCRIPTIONS—ACID TONICS.) In women flatulent dyspepsia is often accompanied by palpitations, headaches, attacks of giddiness and faintness, &c. In such conditions the aromatic spirit of ammonia with spirit of chloroform is very beneficial. (See PRESCRIPTIONS—AMMONIA MIXTURES.) The popular remedy, peppermint water (2 table-spoonfuls) or 2 drops of oil of peppermint, gives temporary relief. So also does ginger, 5 to 20 grains in warm water, or tincture of cardamoms, a tea-spoonful in water.

(5.) **Indigestion with Excessive Appetite.**—There is a persistent feeling of emptiness in the stomach, uneasiness, and craving for food even a short time after food has been taken. These sensations are accompanied by a feeling of weakness, of "goneness" as many express it. This craving for food is termed **bulimia**, and is common in women. The condition seems often due to the food being too rapidly passed on from the stomach into the bowels, so that digestion is not properly accomplished. Looseness of bowels usually is present.

The **treatment** for this kind of indigestion is opium in some form or another, and in very small doses. Let the person begin with a drop of laudanum *before meals*, and if this quantity is not sufficient let the number of drops be slowly increased till the proper dose is found. In no case, however, should the dose exceed 10 drops or thereby, and *as soon as the symptoms have disappeared its use should be given up*, only to be resorted to again if the symptoms return.

(6.) **Painful Digestion.**—Pain is an accompaniment of various kinds of indigestion. Heartburn is one kind of pain, and flatulence usually causes pain also. In these cases treatment for the acidity causing the heartburn, or for the flatulence, ought to remove the pain. Again a sense of uneasiness may grow to actual pain in slow and weak digestion, for which the remedies mentioned under SLOW DIGESTION ought to be used. The pain may take a spasmodic character, and may extend to the back between the shoulders—the kind of pain popularly called "**cramp in the stomach,**" and more learnedly **gastrodynia** (*gaster*, the stomach, and *odune*, pain or anguish). The nitrate of bismuth in 10-grain doses is very useful for this, and if this fails 3 grains of the compound ipecacuanha powder should be added to it. Sometimes the hydrochloric-acid treatment (4 to 8 drops *immediately after a meal*) is efficacious for this affection also. The **water-brash** (*pyrosis*) is another form of painful digestion. Pain at the pit of the stomach is followed by the putting up of mouthfuls of a watery and sour, or sometimes insipid, fluid. The pain is often severe, and the quantity of fluid considerable. Bismuth should be used as prescribed for cramp in the stomach. If necessary, acids may be tried before food if the fluid put up be sour, after food if it taste insipid.

In some cases pain is experienced when the stomach is empty, and is relieved by food. Eating a small biscuit often puts away the pain at once. A little magnesia or a tea-spoonful of aromatic spirit of ammonia may be employed if needful.

Such, then, are the main types of indigestion. Again, however, it must be noted that the dis-

tinctions drawn are merely those of convenience, and that no real distinctions can with certainty be made. Even after proceeding in the most careful and rational manner, treatment of dyspepsia may fail till several remedies have been tried.

One or two additional remarks of a general character may be made.

It will perhaps be noticed that alcohol is nowhere advised in these paragraphs. This is not because it is valueless, but because of the risks involved in recommending it. Many people need only the hint that whisky or brandy would be useful, to seize upon it, and make it an excuse for tippling. Indeed one may say that the cases are so few where some substitute for alcohol cannot be found, that it is safer to leave its prescribing to the hands of a medical man who has immediate knowledge of the individual case.

While a certain amount of water is necessary for the digestion of food, dyspeptic symptoms are frequently due to the immoderate use of water during meals. It should be taken chiefly at the end of a meal and in moderate quantity. Iced drinks during meals frequently hinder digestion. (Details as to drinks are to be found in the section on HYGIENE—Food.)

Dyspepsia may be due to no derangement of the digestive process, properly speaking, but to confirmed costiveness. The remedy in such a case is to correct the sluggish bowels—it is frequently the large bowel that is at fault. A drug highly recommended for this is belladonna, the method of using which is stated in the paragraphs on costiveness (p. 184).

In women various forms of indigestion are frequently connected with affections of the womb and derangements of its functions. Often as soon as these are rectified the dyspeptic symptoms disappear.

Hiccough or Hiccup is a symptom of stomach derangement which has not been mentioned in preceding paragraphs. It consists of sudden, short, convulsive inspirations accompanied by a peculiar sound, and followed by an expiration. It is due to convulsive movements of the diaphragm (p. 130), and is excited by irritations of the stomach due to errors in diet, &c. If it continue for any time it becomes extremely painful. It becomes very exhausting in cases where it is removed with difficulty. Drinking, it is well known, occasions it, and sometimes it persists for days, to the extreme distress and anxiety of the patient. It is also an occurrence in hysteria, and may attend serious diseases of lungs or liver, fevers, &c.

Treatment.—Simple cases are sometimes met by taking a few deep inspirations and then holding the breath as long as possible. A sudden slap on the back or a sudden start often drives it off. A drink of cold water may arrest it. These measures failing, various remedies may be used—a tea-spoonful of aromatic spirit of ammonia in water, a few drops of spirit of camphor in water, or 10 grains of bismuth in water. Obstinate cases have been immediately cured by the drinking of an infusion made with a tea-spoonful of mustard steeped in 4 ounces of boiling water for twenty minutes and then strained.

Colic is another symptom of intestinal derangement which requires special mention. Pain, as has been seen, is a frequent symptom in dyspeptic conditions. In colic the pain is experienced across the belly about the region of the navel. It is due generally to irregular and spasmodic contractions of the large bowel—the colon, hence the word colic. The pain is of a severe twisting character, and comes on in paroxysms, occasionally so severe that the patient rolls and twists about, usually doubled up and grasping his belly, crying and groaning like one bereft of reason. Constipation of the bowels is usually present, and the pain may occasion vomiting. Often, however, severe colicky pains are the forerunner of looseness of the bowels, caused by some food which has disagreed. The pain may be caused by wind, the discharge of which greatly relieves. There is no fever with the attack, indeed the pulse is usually lowered, and the face pale and anxious looking. This helps to distinguish colic from an inflammatory attack. Another great distinction is that pressure on the belly relieves, while, if the pain were due to inflammation, pressure could not be endured. The attitude of the person and the pressure he himself exerts with every renewal of the attack show that it is not an inflammatory affection that is the cause of the disturbance.

The passage of a gall-stone or a stone from the kidney—biliary or renal colic—is not to be confounded with this affection. (Refer to DISEASES OF LIVER OR KIDNEY.) Lead colic is discussed under LEAD POISONING. (See INDEX.)

Treatment.—Let hot cloths or bags of hot salt be applied over the belly at once, and let a full dose of medicine be given, castor-oil or some such simple medicine. A large injection of water at a gentle warmth will probably bring relief. Along with the castor-oil, or a short time after it, may be given (*to an adult*) 30 drops of laudanum.

Constipation and Diarrhœa.

Constipation, or costiveness, is that condition in which the ordinary passage of matters from the bowels is less frequent than is usual, or the quantities passed less in amount than usual. The common rule is that a person should go to stool once a day; but this rule must not be indiscriminately applied. There are plenty of exceptional cases, cases where persons regularly have only one passage in two or three days, with whom a greater frequence indicates something wrong, and who, with the less frequent passage, are in perfect health. With a few people, indeed, once a week is the rule, and there are even cases on record of persons who for years had an interval of several weeks without going to stool, and that without any manifest impairment of the usual state of health. It would, consequently, be wrong to insist that everyone, without exception, should have a daily passage, to be effected by the use of medicine if it did not occur naturally. The question should always be asked, What is customary? If a two or three days' interval has been the rule in the person's life, do not interfere; if the two or three days' interval is a departure from the usual, even though it be a departure which has lasted for some time, efforts should be made to restore what has been customary. There may be various causes for costiveness. It has been seen (p. 139) that the various materials contained in the bowel are propelled along it by contractions of the muscular walls. The contractions are of a remarkable kind, not occurring in the whole tube at once, but passing along it in waves, one region contracting after another. The movement is called *peristaltic*, because it occurs in steps or stages. Now if this movement be very vigorous the food will be hurried along, will quickly reach the rectum, which may in turn as quickly expel it, so that looseness of the bowels is occasioned. On the other hand, if the muscular walls have lost their tone the peristalsis will be feeble and the movement correspondingly slow. Further, as the materials move along, the nourishing and watery parts are removed, and therefore the more slow the movement the more firm and compact will become what is left. In the large intestine the pouches in the wall (p. 140) will offer great difficulties to the advance of the fæces, and so extreme constipation results. It is also clear that, though the muscular contraction of the bowel be efficient enough, if there has been a scanty quantity of secretion from the liver, pancreas, and walls of the intestine, the alimentary materials may be too dry, and their advance will be delayed. Thus deficient secretion into the bowel, especially of bile, or want of tone in the muscular walls, in fact, sluggishness of the intestinal tract, may be the cause of costiveness. Now it is of the utmost consequence to observe that this sluggishness may be determined and developed directly by persons themselves. The feeling of a necessity to go to stool is an indication of peristaltic action occurring in the rectum in the endeavour to expel the material lodged there. If the inclination is resisted, the action, being ineffectual, becomes exhausted; and if this resistance is a daily occurrence the healthy tone of the bowel is lost, both because of the opposition it continually meets, and also because the matters, allowed to accumulate in the rectum and parts above it, distend unduly these parts, and overstretched structures always lose tone. Sluggish action of the bowels is also induced by want of exercise. Many articles of diet are constipating. Every man ought to know for himself what substances act thus on him; but an exclusively animal diet tends to costiveness, while a vegetable diet is the reverse. Very dry feeding is also binding. There are also mechanical causes of constipation, such as have been noted under OBSTRUCTION OF THE BOWELS (p. 164).

Women should note that certain misplacements of the womb occasion great obstacles to the passage of the fæces, simply by pressing against and blocking the bowel, and the consequent costiveness seriously aggravates the uterine trouble.

Symptoms.—The main symptom is evident, but others attend it, such as indigestion, want of appetite, headache, dulness, lowness of spirits, and uneasiness about the region of the stomach and bowels. A bad complexion and foul breath are also results.

Treatment.—If what has been said about the causes of constipation has been understood, the treatment will, in many cases, be evident. First of all, the habit many busy men have of delaying going to stool till it suits their business must be stopped. The habit of going to the water-closet at a certain time every day should be adopted. The best time is perhaps after breakfast, at any rate after a considerable meal. This may be vain at first, but, if persisted in, will in the end be beneficial. If this is not effectual it may be assisted by means which rouse the contractions of the bowel. Of these one very successful is the injection, by means of an elastic ball, of a quantity of tepid

water and then of cold water. This, repeated for two or three days at the same hour, will in very many cases be sufficient. This form of treatment may be aided in various ways by the use of vegetables and fruits at meals, provided they otherwise agree, and ripe fruits in the morning, figs, prunes, &c., the use of bran bread instead of fine white bread, the drinking of a tumbler of fresh water on rising, or on going to bed, &c. &c. Many men find that if they do not smoke a pipe or cigar after a meal constipation results. Along with the use of such means exercise must be regularly taken.

Should these measures fail Trousseau recommends the use of a pill of ⅛th grain of belladonna taken daily before breakfast. Two may be taken together at the beginning of their use, if necessary, but they are to be discontinued as soon as possible. In many cases where the liver is slow a pill of ⅛th grain of the resin of podophyllin and ⅙th grain of extract of nux vomica is effectual when taken before breakfast. Brisk purgatives should be avoided as long as possible. If necessary, however, the best purgative is castor-oil, which may now be obtained in gelatine capsules for those who could not otherwise take it. Sometimes purgative medicines fail to give relief because hardened fæces have been allowed to accumulate in the rectum. The proper treatment for this is the injection of a strong stream of soapy water by means of an enema (see MEDICAL AND SURGICAL APPLIANCES) till the hardened mass becomes softened and loosened. Finally, a drug has lately been introduced for obstinate constipation, the Cascara sagrada, the bark of *Rhamnus Purshiana* from the North Pacific coast. It may be taken as extract, 2 to 8 grains in pill, or as fluid extract, of which the dose is 10 to 60 drops. It has a very disagreeable taste, and a cordial has now been made to disguise the taste, of which 15 drops to one teaspoonful is a dose. The quantity that is found necessary in each case should be taken and gradually reduced till it can be stopped altogether.

In women during pregnancy constipation is often very troublesome; for this nothing is better than a wine-glassful of Hunyadi Janos mineral water every morning before rising.

Diarrhœa is derived from a Greek word *diarreo*, meaning to flow through, and is applied to the condition in which the stools are frequent and watery.

Its **causes** are various. Some food that has been taken may not agree, may irritate the mucous lining of the stomach and bowels, and cause an excessive secretion of the intestinal juices, or may stimulate the bowels to too energetic contraction. The presence of worms will act as an irritant. Similar results may be brought about by the catarrhal condition already described (p. 154) as producing the copious discharge from the nostrils, throat, &c. Thus the condition so well-known as "cold in the head" may have its likeness in a catarrh of the bowels. Emotions of various kinds may produce diarrhœa, the "*diarrhœa a timore*," looseness from fear, for example. In many women of a hysterical tendency the least excitement will provoke the flux. A kind of nervous diarrhœa is common in women about the time of the "change of life," and is accompanied by flushings and sweatings. It should not be forgotten also that an irritation applied only to the anus or lower part of the rectum may determine a flux from the large intestine above and even from the small intestine. This is undoubtedly because of the nervous communications distributing, so to speak, over the whole bowel, the effect of an irritation experienced at one part of it. This explains how piles produce griping and diarrhœa. Further, it is necessary to remember that articles of food, ordinarily quite easily digested, will produce indigestion, griping, and looseness of bowels in some. Thus Trousseau says: "I knew a man who suffered from diarrhœa for years, notwithstanding the trial of every sort of treatment, and whose general health was seriously impaired by the affection. The symptoms disappeared as if by enchantment upon the patient, of his own accord, discontinuing tea for breakfast, which for twelve years he had been in the habit of taking. I attended the family of a shipbuilder at Havre whose children were unable to tolerate milk for the first seven years of life. A few mouthfuls of any kind of milk at once caused diarrhœa and vomiting." It must also be noted that diarrhœa is a common symptom in various diseases, in chronic inflammation of the bowel, in diseases of the liver and spleen, in typhoid fever, in tubercular disease of the bowel. (See CONSUMPTION OF THE BOWELS, &c.)

Symptoms.—Besides purging, sickness and vomiting occur, and there are loss of appetite, furred tongue, and thirst. In most cases also griping is a feature, flatulence, and belching. Where the pain is severe, the person may be much prostrated; his skin may be cold and pulse feeble. In what is called **summer diarrhœa**, or **English cholera**, the attack is often occasioned by errors in diet, by eating tainted meat, unripe fruits, herrings, &c., and begins suddenly with

vomiting, which is frequent, and speedily accompanied by purging. Pain across the belly is severe. The irritating nature of the discharge causes a constant feeling of need to go to stool, which the patient would fain not do because of the painful straining that ensues. What passes is very watery, and contains often bile-colouring matter. The vomit is generally, after a little, also coloured with bile, because the retching has forced bile into the stomach from the small intestine. The patient speedily becomes seriously weak, cold, and complains of cramps in the limbs, and the features are pinched and sunken. A similar form attacks children, and is called infantile diarrhœa. It is spoken of under DISEASES OF CHILDREN. **Lientery** is the term applied when the stools that are passed consist largely of undigested food. It indicates excessive action of the intestinal wall, and that the food has been hurried through the bowels. This shows how the character of the motions may afford valuable indications of the nature of the attack. Thus if the early motions are covered with mucus, as with a coat of glueylooking material, this indicates excessive secretion and intestinal irritation.

The **treatment** of diarrhœa should not proceed on any rule of thumb, but the person should try to make out whether the probable cause is *connected with the diet* or *catarrh* (cold), or *the presence of an irritant*, or *excessive action of the intestinal coat*, or *nervous*, and treat accordingly.

In the case connected with diet, altering the food, and exercising watchfulness in the matter of eating and drinking, is probably all that will be necessary.

If the attack be dependent on a chill, let the oatient rest, and feed on light soups for a day or two, and it will probably readily disappear. If medicine be necessary, a saline purgative should first be taken early in the morning, a dose of seidlitz-powder or rochelle-salts. If, after the action of the salts, the diarrhœa does not abate, then let the subnitrate of bismuth be taken in combination with prepared chalk, 20 grains of each, several times a day. If these fail, 5 grains of the compound ipecacuan powder should be added to the dose.

If irritation of the intestinal canal is suspected to exist purgative medicine should invariably be given first, ½ ounce of epsom or glauber salts, or a dose of castor-oil. After the irritant may be supposed to be expelled, the bismuth and compound powder of ipecacuan should be used.

For nervous diarrhœa, and the type called lientery, some preparation of opium is proper. It must be given in small doses, drop doses, 1 to 5 drop doses of laudanum taken before food (*but only to adults*). In the nervous form, 10 to 15 drops of ether may be added to the laudanum. For *summer diarrhœa*, which comes on usually with great rapidity and severity, the treatment consists in keeping the person quite quiet in bed, and in the administration of such soothing drinks as may be expected to some extent to calm the irritated mucous membrane. Chicken-broth seems to answer this purpose well, also iced water, rice-water, barley-water, flour and water. To the same end hot applications, a mustard poultice, a hot flannel sprinkled with turpentine, &c., may be laid over the belly. Ipecacuan powder, and in large doses, 20 grains repeated every two or three hours, is strongly recommended. Stimulants are also required—the ether-and-ammonia stimulant being most useful. (See PRESCRIPTIONS—STIMULANTS.) One is strongly tempted to use opium. If employed it must be with great care. The best way would be to add 5 drops of laudanum to each dose of the ether mixture, and to watch how it acted. It could be repeated every two hours if the patient bore it well, and the dose of laudanum even slightly increased if experience showed it proper in the individual case, or the chalk, catechu, and opium mixture may be given carefully. (See PRESCRIPTIONS—DIARRHŒA MIXT., p. 1056.)

The difficulties attending the treatment of summer diarrhœa are, however, so great, and the disease is so rapidly exhausting, that no delay should be permitted in the summoning of a qualified physician. In all cases of chronic diarrhœa also the difficulties of obtaining a remedy are so great that medical advice should be sought so that the details of the particular case may be duly examined into.

It must be noted that nothing is here said about summer diarrhœa of infants, which is treated of under DISEASES OF CHILDREN. It is also necessary to note here that nothing is more dangerous than the administration of laudanum or opium in any form to children. A single drop of laudanum will often throw a child into a stupor for forty-eight hours.

Dysentery and Cholera.

Dysentery (*Bloody Flux*) is an inflammation of the large bowel, and specially its lower end. The mucous lining of the bowel becomes intensely congested and, if amendment do not

occur, ulceration ensues. Patches of the mucous membrane die and become detached, leaving ulcers. Thus a great extent of the large intestine may become stripped of its mucous membrane and ulcerated. Should recovery take place and this heal, it is at the risk of narrowing and seriously contracting the tube.

Dysentery is not common in Great Britain. It is most common in tropical countries, and specially where the land is low and swampy. It is the plague of armies in the field. It has been supposed to be due to wet and cold succeeding great heat. No doubt bad food, bad air, and specially bad drinking-water are powerful causes in determining its occurrence. It is not infectious, that is to say one may nurse dysenteric patients without running the slightest risk of "catching" the disease from them. It is not certain whether it is contagious, whether, that is, any of the discharges of patients getting into a water supply, for example, would be likely to give rise to the disease in those who drank of the water. It occurs in districts where ague is common, but does not seem to depend on the poison of malaria, since it is common where there is no risk of malaria.

Its **symptoms** are as follows: a patient who for a short time previously may have felt "out of sorts," or have been feverish, with hot dry skin and clamminess of mouth, is suddenly seized with diarrhœa and passes a large loose stool. Soon after he has a great desire to go to stool again, and becomes tormented with the feeling of something requiring to be dislodged. He sits straining at stool, discharging only small quantities of mucus—glairy transparent material. The painful straining (**tenesmus**) and burning pain about the anus are characteristic. The discharge is frequently mixed with blood, and contains no fæcal matter, properly so-called, except a small quantity which occasionally comes away in little hard lumps. This distinguishes diarrhœa from dysentery, since in the former the discharge is mainly of fæcal matter, though liquid. There is, therefore, in dysentery really retention of the fæces. There are also tormenting pains of the bowels (**tormina**). After eight days or more the stools become very offensive, cease to be mucous, and have the appearance of flesh washings with shreds floating in them, like fragments of overstewed meat. The patient in severe cases is highly fevered, flushed, with foul tongue, headache, and thirst. He suffers from flatulence, and has pain in making water, which is scanty and high coloured. Extreme prostration with faintness, weak pulse, hiccough and vomiting, and a feeling of sinking at the heart indicate a fatal termination to the disease. Cases that recover begin to mend about the sixth or tenth day, the straining being diminished as well as the frequence of the stools. The acute disease may pass away, leaving a chronic affection, the patient suffering constantly from colicky pains and loose stools, with tenderness of the belly, till, months or years after, he may succumb to disease of the liver induced by it.

Treatment.—There has been much controversy as to the appropriate treatment for dysentery, calomel, opium, ipecacuan, and various other remedies having their advocates. Trousseau, the distinguished physician of Paris, who bases his method upon observations of several epidemics of the disease, describes his treatment as follows: "At the beginning of the attack I prescribe ipecacuan in emetic doses—46 grains are divided into four powders, one of which is taken every ten minutes till vomiting is induced. Next day, and often even on the evening of the same day in which the ipecacuan has been thus administered, I give one of the neutral salts (sulphate of soda, sulphate of magnesia, that is, epsom-salts, or rochelle-salts) in a dose of from ½ ounce to ¾ ounce, which ought to be repeated during the following twenty-four hours. I go on giving the saline medicine till there is an evident change in the nature of the stools, or in other words till they cease to contain glairy bloody matter and become of the nature of diarrhœa stools." He also during the same time injects into the bowels by means of a syringe, a solution of 15 grains sulphate of zinc in 7 ounces of water, keeping the solution in the bowels as long as possible. He strongly objects to the improper use of opium, employing it only for checking pains and vomiting, and then giving only drop doses of laudanum every hour till the pain or vomiting is relieved. For diet the patient gets barley-water, rice-water, or toast and water, and thin broths. The liquid extract of the Indian Bael fruit has been much recommended, in doses of one to four tea-spoonfuls. In chronic cases the patient should wear flannel round the belly, should use simple diet, milk, eggs, &c., no vegetables, and take iron and quinine tonic. An injection of tincture of witch hazel (*Hamamelis virginica*) may be tried, a tea-spoonful of tincture in 3 ounces of water to be injected and retained.

Cholera (*Epidemic Cholera, Asiatic or Malignant Cholera*) is properly an acute contagious disease, a general disease perhaps, and not simply

a disease of the bowels. It might properly have been classed under other acute infectious and contagious diseases, but it will be convenient to consider it alongside of diarrhœa and dysentery, with which it has so many things in common.

Cholera first appeared in Great Britain in the autumn of 1831, beginning at Sunderland. In the following year it reached America, attacking Quebec. The disease had travelled all the way from the Delta of the Ganges, where it broke out in 1817, and from which it spread all over Asia and entered Europe through Persia in 1829, reaching Russia and Poland in the spring of 1831, and England a few months later. It thus took fourteen years to travel from India to England, but its progress though slow was sure. It came by no unknown and deserted pathways, but by the highways, and along the paths of human intercourse. In fact there is no doubt it did not travel alone; it was brought, carried from place to place by caravans, by ships, by bands of pilgrims. In 1848–49 it again appeared in Britain, again in 1853–54, and in 1865–66, carried to the country in each case by persons, passengers or sailors, who had come from some infected region in the East. For, though the outbreak of 1817 in India was the first of consequence to Europeans, the disease appears to have been common in India centuries before that.

It is a very fatal disease, causing the death of about 50 per cent of those whom it attacks. It kills with great rapidity, sometimes in two or three hours, in many cases within twenty-four. It spreads with frightful rapidity. In 1853–54 it had in England 70,000 victims.

For such reasons as these the mention of cholera provokes a panic; yet in the eyes of reasonable men it should not. For cholera can be grappled with perfectly successfully, but only in a certain way. Its immediate cause is yet obscure. The epidemic in Egypt of 1883, which reached France in the summer of 1884, led to careful investigations being made in Egypt, India, and France by distinguished English, German, and French experts. Dr. Koch of Berlin, one of the most able of the investigators, believes he has succeeded in finding its special cause in what is called a *bacillus*, which he has found in the intestines and in the discharges of all cholera patients. Bacillus is derived from a Latin word *bacillum*, meaning a little stick, and is a very minute rod-shaped body, discoverable only with the aid of very highly-magnifying microscopes. There are various forms of these rod-shaped bodies, one supposed to be the cause of splenic fever, another of intermittent fever. Another was discovered by Dr. Koch in the spit of consumptive patients, and is supposed to have something to do with causing consumption; and now the same scientist believes cholera to be produced by another form, which he describes as like a comma (,). These bacilli are considered as likely to be the germs of disease, the minute seeds, which, when introduced into the body, if they find it suitable, begin to multiply with extraordinary rapidity in the blood and other fluids, and occasion the symptoms of the disease. Just as one must plant oat seeds to grow oats, and wheat seeds to grow wheat, and potato seed to cultivate potatoes, so it is held must the germ of a disease, the special bacillus of the disease, be sown in the body and take root there and flourish before the person can suffer from the disease.

Now there are two things of great consequence to note here in connection with such a view. The first is, you cannot have cholera unless cholera seed has been sown; and the second is, that cholera seed may be sown, but the soil may not be favourable for its growth, and it may not develop. In other words a person cannot have cholera unless he has somehow or other been infected by cholera poison obtained from a previous case of cholera; and a person may be exposed to the cholera poison, but may not suffer from the disease because he is not suitable for its development, because he is not a fit subject for it. Let us see what these things mean. Suppose a person to be plagued with weeds in his garden, and to be anxious to get rid of them. He would watch for their springing up, and would remove them as soon as they appeared. He would never let them come to seed and let the seed be scattered, for he would know that that ensured a bigger crop very speedily. If perchance one escaped his eye, and he noticed it only when it was in seed, he would not be content with pulling it up and throwing it down where the wind might scatter its seed. He would take care to destroy the seed entirely by burning or in some such way. Now cholera is produced by some poison, which to all intents and purposes is the seed of the disease; it may be that Koch's bacillus is the actual seed, it may not be so. At any rate cholera is produced in a person by a poison which has obtained entrance to his body in food, drink, and so on, and it multiplies in his body. Equally certainly is the poison contained in the discharges which come from the patient.

Now suppose the discharge is carelessly thrown on to the land in the neighbourhood of a well, and that some of it enters the well, the cholera poison multiplies fast in water, and the well soon swarms with the seeds of the disease, which nevertheless the unaided eye cannot see nor the taste suspect. Everyone who drinks of that well is liable to be seized with the disease, because the germs are present in the water. Thus it is that cholera spreads. It has been clearly shown that filth, uncleanliness of every description, is most favourable to it. Specially have those towns been ravaged with it whose drinking-water was impure. Therefore a town, which derives its water supply from a river into which it also discharges its sewage, occupies a very dangerous position, unless the supply be taken from very high up the river, out of all possibility of being reached by the sewage. This was well shown in the London epidemic of 1854, where the people, supplied by one water company with water taken from the river too near the city, were attacked by the disease far more fiercely than people, supplied by another company with water taken very much further up the river, although the people lived in the same district and even the same streets.

That the discharges of patients suffering from cholera contain the cholera poison has been shown by experiments on mice fed with some of the discharge. The mice were rapidly killed by an affection resembling human cholera. The experiments, however, showed this remarkable fact, that the discharges from the cholera patient that had stood twenty-four hours were far less poisonous than those that had stood two days. The discharges that had stood three days were extremely poisonous, every mouse fed with any dying. On the fourth day their fatal character was diminished, and later than five days after being passed the discharges had lost all poisonous qualities, so that of mice fed on them after the fifth day none died. If, therefore, steps were taken to destroy all discharges from cholera patients immediately after they were passed, all risk of cholera being communicated to others would be removed. Cholera, it thus appears, can be stamped upon, if those suffering from the disease are kept scrupulously clean, and if the utmost care is taken that nothing, that can contain any germs of the disease, is permitted to pass from his room without being immediately submitted to the action of some agent that will prevent them developing their poisonous properties. How that may be done is considered later on in what is said under treatment.

Now about the second point, the necessity of the cholera seed finding suitable soil. Just as certain kinds of soil cannot support certain plants, so certain people seem able to resist disease. Everybody has a certain power of resisting disease. There is no better preventive of disease than the possession of vigorous health, and due care of it when possessed. A man may, however, diminish his resisting power and lay himself open to attack from any side. There are, therefore, certain things that help cholera, that tend to make a person more suitable for its development within him. These are personal uncleanliness, the use of bad, unwholesome, or insufficient food, or anything which weakens the system, *and, above all, intemperance.* It seems certain that cholera has specially easy prey among those who are addicted to the constant and improper use of alcoholic drinks. *It was observed that in the epidemic in Warsaw, "90 per cent of the deaths occurred amongst those who used alcohol freely."* Further, alcohol is believed to be "*one of the most dangerous agents that can be used for the cure of the disease.*" It is well that this should be prominently stated in view of the fact that some, knowing nothing of the disease, have advocated that as soon as a person suspects he is about to be attacked by cholera, he should drink alcohol till a condition of complete intoxication is produced.

Symptoms.—Sometimes the patient is suddenly stricken down and dies collapsed within a few hours without diarrhœa or vomiting. Frequently the person may feel unwell for a few hours, or a day or two, and low-spirited, suffering from diarrhœa. When the attack begins, the patient suddenly requires to go to stool and passes a large loose motion, just like that of diarrhœa. Thereafter there issues from him an almost continuous stream of a thin whitish liquid with flaky particles in it. It has no smell of fæces, and is the characteristic discharge of cholera, being called from its appearance the "rice stool of cholera." An enormous quantity of this liquid is passed. A little later vomiting comes on, at first of the contents of the stomach, with perhaps bile, but soon of the same rice-water liquid that pours from the bowel. Severe muscular cramps in the thighs, calves of the legs, and belly come on shortly. Following the first stage of diarrhœa and vomiting is the second, the *algide* stage (from Latin *algeo*, to be very cold), or collapse stage. The "term *collapse* expresses a general condition, made up in the most exquisite cases of the following particulars:—A remarkable change

took place in the circulation, and a striking alteration in the appearance of the patient. The pulse became frequent, very small and feeble, and at last, even for hours sometimes, extinct at the wrists. The surface grew cold, and in most, or in many instances, blue as well as cold. The lips were purple; the tongue was of the colour of lead, and sensibly and unpleasantly cold to the touch, like a frog's belly; and the breath could be felt to be cold. With this coldness and blueness there was a manifest shrinking and diminution of the bulk of the body. The eyes appeared sunk deep in their sockets, the cheeks fallen; in short, the countenance became as withered and ghastly as that of a corpse. The voice became husky and faint." There is suppression of urine, and the diarrhœa and vomiting also disappear at this stage. The intellect is unaffected and the patient wakeful. Death may occur in from two to fourteen hours, and usually within twenty-four. If death do not ensue, the third stage—the stage of reaction—sets in. The patient shows some signs of improvement in everything, colour, pulse, temperature, breathing, &c., till the former symptoms give place to those of fever, hot skin, quick pulse, flushed face, and perhaps delirium. This condition may last several days, and then the patient may begin to recover, or the fever may end in death by exhaustion, or from affections of lungs, brain, kidneys, &c. The case may, however, present varying degrees of severity, recovery beginning after the first stage without previous collapse, or after the second without any fever of reaction.

Treatment.—It is impossible to state any treatment for cholera, so many methods have been tried, and all of so little avail. Diarrhœa should never be neglected—not in any case, but still less during cholera times, or when chances of cholera are present; it may be merely the forerunner of the more serious disease. The patient, of course, must be kept quiet in bed, and may be allowed to suck ice or to sip iced water. At the outset lead and opium should be given. They are best given in pill, containing 1 grain of powdered opium and 6 grains of acetate of lead. It is in the diarrhœa stage the pill is administered, but not later. The frequency with which it is given depends on the patient. In the collapse stage the patient is to be kept warm by hot bottles, flannels, and rubbing. In this stage the person is often recovered from apparent death by the injection into the rectum of warm water (of temperature 100° Fahrenheit), containing various salts in solution. The mixture of salts is made by taking 10 ounces common salt, 1 ounce chloride of potassium, ½ ounce of phosphate of soda, and 3 ounces carbonate of soda. Half an ounce of this, dissolved in 10 ounces of the warm water, may be injected every three or four hours. Injections into the veins of a solution of similar salts, but very much weaker, has had marvellous effects in restoring the person for the time. Light broths, cornflour, &c., form the kind of diet required. Those in attendance on the patient must take pains to keep him clean from contamination by discharges, and must use measures to destroy the chance of his discharges spreading the disease. (See PRECAUTIONS DURING TIMES OF CHOLERA.)

Precautions during times of Cholera.—If cholera be threatened, everyone should see to it that preparation is made to meet the enemy. This will be effected by maintaining the strictest cleanliness in every direction. Let houses be kept thoroughly clean, so that they harbour no dirt; let drains be looked to, that any blocked may be cleared. Drains should be regularly flushed with clean water, and disinfecting material (chloride of lime, &c.) poured into them regularly, say once a week. The streets, lanes, &c., of city and village must also be kept pure, and dust and dung heaps cleaned out, and also regularly disinfected. Care must be exercised in the use of drinking-water, wells being avoided where any chance of pollution exists. Where the water supply is suspected, none should be used without being well boiled or filtered through a charcoal filter. The charcoal must be renewed occasionally or purified by strong heat. If water is boiled, the unpleasant taste may be removed by shaking it up with air in a clean vessel. Tainted meat, vegetables not perfectly fresh, over-ripe fruit, must all be carefully avoided. Milk must be carefully watched and kept in a cool place away from dust.

If cholera be in a house, the person must be removed to one room, and one person made responsible for attendance on him. All useless furniture and hangings should be removed. The room should be well ventilated, though kept free of draughts. It should also be cool. Every cloth used by him and every article of clothing should, before removal from the room, be immersed in some disinfecting solution, a solution of carbolic acid (1 ounce of acid to 20 of water), or a solution of chloride of lime. [The chloride-of-lime solution is made by putting ½ pound of the chloride into a wooden pail, stirring it, and then letting it settle. A quantity of the clear fluid is drawn off and diluted to the

strength required. If it is too strong it will destroy clothes put into it.] The vessels into which vomit or other discharges are received should all contain a disinfecting material. A mixture is made by adding 1 ounce of sulphate of iron and ¼ ounce carbolic acid to 20 ounces of water. A wine-glassful of this should be kept in the vessels. After receiving the discharge, they should at once be emptied into the water-closet, the pipe should be well flushed, and a quantity of the mixture kept in the basin. The vessels, after being emptied, should be immersed in strong solution of the chloride of lime. The patient's body should be kept clean by frequent bathing with acid water (½ ounce sulphuric acid to 20 ounces of water), or with water coloured a deep pink with Condy's fluid. The attendant's hands should be frequently washed in Condy's fluid or carbolic acid solution (1 ounce of acid to 40 of water). On the termination of the case, articles of clothing worn by the patient, the mattress on which he has lain, &c., should be destroyed by fire.

DISEASES OF THE ABDOMINAL CAVITY AND WALLS.

Peritonitis —There has been mentioned on p. 130 the delicate membrane which lines the wall of the belly within, and clothes the intestines. It is called the peritoneum, and it is subject to inflammation, which is called peritonitis.

It is caused by injury. A severe blow on the belly is liable to produce it, and it is often set up by a wound piercing the belly. Cold seems also to produce it. Often it is the result of ulcerations of the stomach and bowels (see p. 159), which eat their way through the intestinal walls, and permit the escape of material into the cavity of the belly, which irritates the membrane and excites the inflammation. It results often from various diseases of liver, kidneys, &c. A grave form occurs in women after childbirth, due, apparently, to the absorption of poisonous discharges from the womb. [Refer to DISEASES OF WOMEN—PUERPERAL FEVER.] Matter may form in the course of the disease, and an abscess be formed within the belly.

The **symptoms** are chiefly pain and fever. The pain is severe, cutting, or burning, and at first usually limited to one place, but it extends. It is increased by pressure, and is thus distinguished from the pain of colic. So severe is the pain that the patient lies on his back, the muscles of his belly on guard to prevent anything coming in contact with it, his knees drawn up to relax the parts. Even the weight of the bed-clothes can hardly be borne. The fever is considerable, pulse frequent and sharp, skin hot and dry, tongue coated, and there is usually costiveness. If the urine cannot be passed, it indicates the inflammation is low down. The disease is often fatal; and the case is very serious if the belly becomes swollen up, if the extremities become cold, the face pale, pinched, and anxious, and the pulse thready and weak. If the inflammation is the result of perforation of the bowel, the pain is sudden and severe, there are cold sweats, faintness, and vomiting, followed by the signs of fever and inflammation, if death do not speedily result. In milder cases there is fever, pain in the belly at one place, increased on pressure, costiveness, furred tongue, &c.

The disease should not be prolonged beyond a week unless it becomes chronic. In chronic cases the symptoms are vague, and include pain in the belly, not very marked and often colicky, tenderness of belly and swelling, weakness and paleness. The swelling is often due to accumulations of fluid—the result of the chronic inflammation.

Treatment.—The patient should be kept perfectly quiet in bed, and hot cloths should be kept constantly applied to the painful region of the belly. The pain must be kept down by opium, of which (to an adult) 1 grain may be given at a time, or 30 drops of laudanum may be given instead. It is to be repeated as seems desirable, the purpose being to keep the pain down, but not to throw the patient into stupor. Vomiting gives rise to great pain, and must be avoided by giving the patient small pieces of ice to suck, and by warm applications over the stomach. Fluid food is to be given—beef-tea, thin soup, milk, &c. The question of relieving the bowels is often a difficult one, because it would greatly increase the risk of perforation, if such were present. It is a question for a medical man to decide, and in any case a warm-water injection is safest. Often the urine must be drawn off by a catheter. (See MEDICAL AND SURGICAL APPLIANCES.) If the patient become weak and collapsed, stimulants are needed.

An abscess that has formed may open into the bowels, and the matter may come away with the fæces. It would be much more desirable that a doctor should discover the presence of the abscess and draw off the matter.

For chronic cases nourishing diet is required, sea-air, friction of the belly with cod-liver oil, iodine liniment, &c.

Dropsy of the Belly (*Ascites*) is an affection that may occur as a complication in various diseases. It may be due, as we have seen, to the accumulation of fluid poured out from the blood-vessels as a result of chronic inflammation (peritonitis). In many cases it is the direct result of too full blood-vessels of the abdomen. Anything which impedes the due return of blood from the veins of the abdominal organs through the liver to the heart is apt to produce it, because the veins and small vessels being gorged with blood, watery portions of the blood filter through the delicate walls of the vessels to relieve the pressure, and thus the fluid accumulates. Its amount will thus depend, among other things, on the fulness of the vessels and the length of time the obstacle to the free circulation has occurred, and may vary from a few pints to some gallons. Now this obstacle may exist in the liver, may be due to simple congestion of the liver, but more commonly to that thickening of the liver called cirrhosis (see p. 196), which is a frequent result of constant drinking. Of course it might be caused by some tumour pressing on the great veins, and thus blocking the return of blood. Disease of the heart or of the lungs, by impeding the due circulation of the blood, may occasion it, because the blood is penned up in the veins, not being able to get along quickly enough.

Symptoms.—The belly is large, swollen, and bulging out at the sides, the blue veins showing on the surface. The question whether the swelling is caused by fluid is settled by "percussion." Percussion is practised by laying a finger of one hand flat on the belly and tapping it sharply with the point of a finger of the other hand. If this be done over the healthy belly a clear sound is heard, like that given out by tapping a hollow vessel filled with air. Now, if the patient lies on his back, the fluid will seek the lowest level, and on tapping on the middle of the belly, which is uppermost, the clear sound will be given out, but on tapping low down at the sides the sound will be dull, like that produced by tapping a solid block of wood. In this way, by tapping all over the belly the extent of the accumulation of fluid is determined. A solid tumour, however, would give forth as dull a sound as a collection of fluid. The determination of the presence of fluid is made by laying the one hand on one side of the belly and giving a sudden tap with the fingers on the other side. If there is fluid present, a wave is sent through it, and a thrill is communicated to the hand resting on the belly. In women there is a dropsy of the ovaries (see DISEASES OF WOMEN), which requires skill to distinguish from dropsy of the cavity of the belly. The legs and genital organs tend to become dropsical from the pressure of the fluid in the belly on the veins there. Breathlessness is occasioned from the mere mechanical difficulty offered by the swelling, and the breathlessness is worse on lying down. Severe diarrhœa sometimes occurs.

The **treatment** depends on the cause of the dropsy. It consists usually in the administration of medicines to cause sweating, a copious flow of urine, or a copious watery discharge from the bowels. On the whole, the two former are not risky, like the latter, for the administration of strong purgatives may seriously weaken the patient when he needs strengthening. There can be no harm in administering spirit of nitrous ether or squill to encourage the flow of urine. Quinine and iron tonics often help by strengthening the patient. The disease, however, should be left to the treatment of a physician. Tapping, that is, passing a fine tube through the walls of the belly to permit the fluid to escape, is practised when the swelling is great.

Other forms of dropsy are considered under the heading of GENERAL DISEASES.

Tumours of the belly may be of a great variety of kinds. They may be connected with the liver, with the kidneys, with the spleen, with the glands of the bowel, and with the bladder: they may be formed by accumulations of matter after peritonitis; in women they may be connected with the womb or ovaries. It is useless to say anything of them here. They offer great difficulties often to skilled men in endeavouring to discover their nature, and the proper treatment for them.

Rupture (*Hernia*) is that condition in which there is a projection of part of the bowel or mesentery (p. 131) through some unusual opening in the wall of the belly, the projection appearing as a tumour or swelling on the outside. In males the tumour usually appears in the groin, and may pass down into the testicle. It is common here, because about the centre of the groin the spermatic cord passes out of the belly and down a canal to the testicle. Usually the rupture forces its way along this canal under cover of the skin, fat, and tendinous layers. In women it may occur in a similar region, or towards the centre of the upper part of the thigh. In

this position the rupture passes down a canal by which blood-vessels pass to the thigh. The former is called *inguinal* hernia, the latter *femoral* or *crural*. Hernia may occur in children at the navel (umbilicus), and is called *umbilical*. It occurs here before the opening is properly closed up which existed for the connection between mother and child by means of the cord.

It is at the parts naturally weaker than others that rupture tends to take place, and it is usually owing to extra pressure exerted on these weaker places that they yield and permit the rupture to occur. Thus sudden straining by lifting a weight, rowing, &c., or the great pressure exerted on the walls of the belly by frequent cough, as in bronchitis or hooping-cough, &c., produces it. The rupture is called *reducible* if it can be returned the way it came into the cavity of the belly, and *irreducible* if it cannot be returned. Another form is called *strangulated*, where constriction occurs.

Symptoms.—There is the presence of a soft swelling. When the patient stands it increases in size, and when he coughs, the hand surrounding it feels an impulse. If the swelling be formed by the bowel, wind may be felt passing through it. When the person lies down, gentle pressure upwards in the direction of the groin, along with a sort of kneading motion, diminishes its size, if it is reducible, and it passes up into the belly, gradually at first, but at last with a bolt and gurgling noise. If it is irreducible, for instance by adhesion having taken place between the bowel and the canal, it cannot be returned, but wind and fæces still pass along the channel. A *strangulated* hernia is a much more serious affair. Here the channel of the bowel is blocked, either because it has got twisted or caught at the neck because of the small opening through which it has passed, or for some other reason. Not only are the contents of the bowel prevented passing along, but the circulation of the blood in the walls may be seriously hindered. The strangled bowel will, therefore, become congested and inflamed. The symptoms are thus those of stoppage of the bowels and of inflammation. Besides pain, vomiting soon occurs, first of the contents of the stomach and of bile, then of matter like that of stools—stercoraceous vomiting, it is called. This kind of vomit should at once show the nature of the mischief, and should lead to the promptest action. The tumour becomes swollen and painful, the patient becomes very anxious, and, if not relieved, quickly begins to fail, the pulse grows small and wiry, the skin cold, and features pinched, and death speedily occurs, perhaps within a few hours after the strangulation.

Treatment.—The protrusion must be returned, if possible, into the belly and kept there. In the case of a reducible hernia this is often easy. The patient lies on his back, with his hips supported and his knees bent, to relax the belly. The tumour is taken in one hand and gently compressed and urged upwards in the line of the groin, a kneading movement being practised till it returns into the belly; a pad is then to be fitted over the place to prevent its return. Pads are made for the purpose, called *trusses*. They are pads kept in place by a strong spring band that passes round the body. A truss should be of the proper size, and carefully fitted over the place out of which the rupture comes. They should be occasionally taken off, and the part sponged, dried, and dusted to prevent fretting of the skin; but the patient should be lying down when this is done, to prevent the coming down of the tumour.

In a woman a rupture in the upper part of the thigh must be gently pressed, not upwards, but slightly downwards and backwards, because, after escaping from the canal through which it comes, it bends upwards towards the belly. Strangulated hernia requires immediate relief, and a surgeon should at once be summoned. Till he arrrives the patient should lie on the back, with the hips high and the shoulders low, to take off pressure, the knees being bent up. Iced cloths or an ice-bag, separated from the skin by a fold of flannel, should be placed over the tumour, but not kept on till the part is too cold. The surgeon may be able to relieve the patient by the aid of chloroform without an operation, which, however, is often necessary, and is rather to be welcomed by the patient in view of the serious risks delay gives rise to.

The best way to prevent a strangulated hernia is never to permit a rupture to remain down, however used one may be to it, as strangulation may arise in an old rupture which has given no trouble.

Again, if anyone is seized with sudden pain and vomiting, rupture should be examined for. These symptoms are sometimes caused by a rupture not quite down, and needing careful examination for its detection.

DISEASES OF THE RECTUM AND ANUS.

Fissure of the Anus is an extremely painful affection caused by a small crack or ulcer. The pain on passing the motions is intense, and lasts

for a considerable time afterwards. The crack or fissure may be very trifling, but is just within the anus, where it is grasped by the circular muscle or sphincter which keeps the bowel closed. It is its position that makes it so painful. A careful inspection of the parts will reveal its presence. The pain caused during and after going to stool leads those troubled with fissure to delay as long as possible, and thus tends to create costiveness and similar troubles.

Treatment.—The object of treatment is to ensure rest of the sphincter muscle for a few days, since it is its movements that prevent the ulcer healing. Therefore complete division of the muscle by the knife was found the most effectual treatment. It was found, however, that division of the fibres of the muscle just under the ulcer was sufficient. This has been further simplified by simply stretching the anus forcibly, so as to paralyse the muscle for a little time. This is done by passing up the well-oiled thumb of each hand into the rectum, and then, by stretching the fingers over the buttocks and pulling on them, the thumbs are drawn apart and the sphincter forcibly stretched. This is all that need be done. It is not even necessary that the patient should be confined to bed.

Ulcer of the Rectum is higher up than the preceding. It produces uneasiness in the rectum, and a desire to go to stool, especially on rising in the morning. At such times what passes may be streaked with blood or contain matter, or the motion may be of the coffee-ground appearance, significant of blood being mixed with it. This ulcer, not being so low down as the preceding, will not be visible to ordinary inspection. A surgeon would probably require to give chloroform before making a satisfactory examination.

The **treatment** consists in clearing out the bowels well with castor-oil. Thereafter various kinds of injections may be used to heal the ulcer. Without surgical advice one should use only an injection of tepid water, or of thin arrowroot and water, or thin starch and water, employing a pint of the solution after every motion. The division of the ulcer may be necessary before it heals.

Piles (*Hæmorrhoids*) are a form of varicose veins (p. 247). They consist of folds of the lining membrane of the bowel which are swollen, thickened, and congested, and contain enlarged vessels. If they have grown to any extent they are forced out by straining at stool, and the pressure thus occasioned may cause them to bleed. They may thus form little tumours of the size of a pea or a nut, which produce great discomfort and pain. This is the form called *internal piles.*

They are caused by anything which produces overfulness of the veins of the belly. Thus anything interfering with the return of blood to the heart will tend to produce them, congested liver, pressure on the large veins such as is frequently exercised by the pregnant womb, &c. Luxurious living, with lack of exercise, and costiveness, produce them.

External piles or blind piles are little masses at the margin of the anus, consisting chiefly of overgrown skin and connective tissue.

Symptoms.—There is pain at stool, with heat, and throbbing, and straining, and often with the discharge of blood. Irritability of the bladder may be produced, and in women irritability of the womb with discharge. The general health may be affected, and the complexion become sallow, the liver, stomach, and bowels become deranged, and loss of flesh may result. Sometimes, after being forced down at stool, the piles may become so swollen and engorged by the pressure that the person is unable to return them, and they remain down, bleeding perhaps and exquisitely painful. They are, if not returned, liable to slough.

Treatment.—The bowels must be moved regularly, and the motion must be soft and easy to save pain and straining. For this purpose perhaps nothing is better than the old sulphur electuary, made of 1 ounce of sulphur, 4 ounces of cream-of-tartar, and 4 ounces of syrup or treacle, of which a teaspoonful, or the quantity that is found necessary, should be taken every morning before breakfast. After each stool the parts should be sponged with cold water, and then an ointment of galls and opium applied—the gall-and-opium ointment of the chemists. An injection of cold water into the rectum both before and after stool is useful. The food should be plain and nourishing, no highly spiced, very fat, or sweet dishes being allowed. If piles cannot be replaced after they have come down, iced clothes should be applied till their size is so reduced that replacement is possible. If they have become strangled and tend to slough, poultices must be employed, the pain being relieved by opium (1 grain for a dose). The radical cure is removal, which can easily be done by operation.

Bleeding from the Rectum sometimes occurs as the result of piles. The blood may be noticed in the stools, in which case the blood

is separate from the fæces, not mixed with them, and is of a red colour.

Treatment.—If the bleeding be not excessive in amount, a course of gentle opening medicine should be adopted, such as the daily morning use of a mineral water like Hunyadi Janos or Carlsbad. Where the blood is spouting, however, it must be stopped. This may be accomplished by pieces of lint pushed up the rectum one after the other. Each piece must, however, be connected with the outside by a piece of string or in some such way, so that, on removing them, one may with certainty know that none has been left behind. The lint may, if necessary, be steeped in some astringent solution—glycerine and tannic acid in solution being preferred.

Abscesses near the rectum may be caused by various circumstances, among them by piles. They are attended by pain, throbbing, and swelling round the anus. If large, they may produce serious disturbance of general health, fever, sickness, &c. They are to be treated on the same lines as any other abscess would be treated (see ABSCESS), that is, with hot applications, &c., the abscess finally to be opened and cleaned out.

Fistula in the anus is that condition in which a channel passes from the outside inwards along the side of the anus, and finally opens into the bowel at some distance from the outside. It is thus a canal with two openings, one at its inner end into the bowel, the other on the surface near the anus. Fistula is a common result of an abscess at the side of the anus. A discharge comes from it, and fæces are apt to pass through it, hence the difficulty in the way of its healing. Sometimes there is an opening near the anus from which a canal leads inwards, but terminates without opening into the bowel. This is called a blind fistula. It is a remarkable fact that fistula is common among patients affected with consumption. It is a popular notion that in such a case curing the fistula and stopping its discharge will seriously harm the patient. This is a gross error. The curing of the fistula must benefit the patient's health.

The proper **treatment** of fistula is by a surgical operation. The fistula is alongside of the anus, and any tendency to heal will be thwarted by the movements of the muscle of the anus. The operation divides this muscle, opens up the channel, and permits it to be thoroughly cleaned. The part is thus kept at rest and is accessible to proper dressing, so that it is in a good position for healing. Apart from this treatment, cleanliness by frequent bathing, &c., is the only thing that is necessary.

Falling of the Bowel (*Prolapse, or Coming Down of the Bowel*).—This consists of the protrusion of the lower part of the bowel beyond the anus. It is common in children (see DISEASES OF CHILDREN) and in old age. It is caused by straining as a result of costiveness or of diarrhœa, or as a result of the irritation of worms, &c. It may be due simply to want of tone of the bowel.

The part that comes down is of a deep pink colour with wrinkles and folds, and is to be distinguished from piles, which are dark, swollen, and livid.

Treatment.—The part must be returned after being gently bathed with tepid water. The fingers are well oiled and used to push the bowel back. No force must be exerted, however. Usually it slips back easily. If it is swollen and tender it will be more easily returned after bathing with cold water. To prevent its recurrence straining must be avoided; costiveness and other irregular conditions of the bowels must, therefore, be rectified. To restore the tone of the part cold sponging and the administration of tonics, especially iron tonics, are to be employed.

Itching of the Anus (*Pruritus*) is very troublesome, and afflicts elderly people, and specially those of a gouty disposition, those addicted to high living or to drink, or who suffer from want of exercise. The region round the anus may be all scarred and raw with scratching.

Treatment.—First and chiefly let the diet be properly rectified. Let the person be sparing, and use plain food, free from alcohol, coffee, and seasoned dishes, and let exercise be freely taken. Saline medicines—seidlitz-powder and such aperients—should be used frequently if necessary. The parts should be bathed regularly with cold water, and then with a lotion made of corrosive sublimate 2 grains, glycerine $\frac{1}{2}$ ounce, water $\frac{1}{2}$ ounce. An infusion of tobacco is also a good application. Note that in children worms are a frequent cause of itching at the anus.

Foreign bodies in the rectum may consist of substances that have come down from above, gall-stones, fruit stones, &c., or substances like coins, pins, &c., which have been swallowed by accident or design, or of substances pushed up through the anus. Sometimes hardened masses of fæces lodge in the rectum.

Treatment.—The substances must be removed

through the anus, which must be properly widened for that purpose. This may be done by introducing several fingers well oiled. If the hand be small and properly oiled, with care it may be introduced altogether. No force must be used. With time and patience widening will take place. Sometimes a spoon has to be used for scooping out hardened fæces. If the substances are difficult to dislodge it is well to try the effects of a strong current of soapy water from an injection syringe before resorting to such an instrument as the spoon. The use of the syringe for a considerable time may ultimately loosen the impacted substances and permit their removal. Unless it be absolutely necessary none but a qualified surgeon should undertake such cases.

Tumours of the rectum are often indicated by the peculiar shape of the solid motions passed by the person. The tumour may block the rectum to a considerable extent. Cancer is one form of tumour. It is happily not common. It is needless here to discuss tumours of the rectum, since the services of a surgeon are indispensable.

Wounds and Bruises about the anus must be treated as they would be in any other neighbourhood. (See WOUNDS, &c.)

DISEASES OF THE LIVER.

Congestion of the liver.—The structure of the liver has been described at page 141, and the way in which it is permeated with blood-vessels has been noted. Normally the liver contains about one fourth part of the total amount of blood in the body. It can be understood, however, that if these numerous blood-vessels, instead of being ordinarily filled, were choked with blood, the liver might contain an enormous amount, and that, if it could be seen in that condition, it would appear of a deep red colour, and would feel hard and tense owing to the amount of blood contained in it.

The liver may be congested from various causes. Anything which prevents the blood, returning from the liver, passing on to the heart, and from that to the lungs, will produce an accumulation of blood in the liver. Thus heart-disease and disease of the lungs act. It may, however, result from much simpler causes—excess in eating or the use of too rich foods, excess in drink, want of exercise. It is very common in people of sedentary habits. Very hot weather occasions it. Malarial disease, ague, &c., produces it. Chronic enlargement or **hypertrophy** of the liver may result from long-continued congestion.

The **symptoms** are weight and fulness in the region of the liver. Reference to Figs. 87 and 91, pp. 131 and 138, will show the limits of that region. The organ becomes enlarged and tender on pressure. This tenderness is often well shown by giving a smart push with the fingers to the front of the belly just beyond the end of the breast-bone. As mentioned on page 141, the liver should be completely covered in by the ribs when the person lies down, except at the part beyond the breast-bone. In enlargement the liver projects beyond cover of the ribs, and its firm edge may often be felt by the fingers. Physicians are in the habit of defining its limits by percussion, as described on p. 191. The sound given out by tapping with the fingers over the liver is dull, while other parts of the belly give forth a clear sound. Thus the boundary of the liver can be ascertained. In congestion there is also some pain, especially on coughing and when lying on the side, pains often also about the right shoulder. Added to this are dyspeptic symptoms, a feeling of sickness, bad appetite, often dull headache, and mental depression. The urine is highly coloured, and there is costiveness. Sometimes there is slight yellowness of the skin—jaundice, seen first in the white of the eye.

Treatment.—Let any discoverable cause of the condition be removed if possible. Thus let plain food take the place of rich stimulating dishes. Let all alcoholic liquors be abstained from, and let regular exercise be taken. Hot applications over the liver will often greatly relieve the sense of weight and the pain. As to medicines, they should be chiefly medicines that will relieve the bowels, saline medicines like seidlitz-powders, Eno's salt, &c. Stout people are liable to be troubled with this condition of liver. They will find great relief by avoiding fatty food, sweet dishes, pastries, &c., and by taking every morning a dose—the quantity they find most convenient—of a mineral water like Hunyadi Janos, Carlsbad, or the waters of Harrowgate or Cheltenham. If additional purgative is required the resin of podophyllin is preferable. One or two pills ($\frac{1}{4}$ grain in each) may be taken occasionally at bed-time, or a breakfast pill of $\frac{1}{8}$ grain of podophyllin and $\frac{1}{6}$ extract nux vomica may be taken every morning. Mineral acids, for example dilute nitro-hydrochloric acid (20 drops), are valuable, and may be combined with the dandelion juice (a tea-spoonful), the dose to be taken

twice or thrice daily a little time after food. In India, chloride of ammonium (sal ammoniac) is largely used in doses of from 5 to 20 grains several times a day, and continued for a long period.

Inflammation of the Liver (*Hepatitis*) is frequent in hot climates, and is closely connected with dysentery, in the course of which disease it often occurs. But inflammation of the liver may also occur from injury—a violent blow on the right side, &c. It may also result from the presence of poisons in the blood, such as phosphorus or the poison of syphilis, &c., or it may be a consequence of other diseases. It may be acute or chronic.

In inflammation of the liver there is, as in congestion, a much greater quantity of blood in the organ. But it is not there simply because it is prevented flowing on quickly enough; it is there because there is an active determination of blood to the inflamed organ. As a result of the inflammatory material which exudes from the blood-vessels, matter may be formed in the liver, and an abscess may result.

The **symptoms** of the acute form are similar to those described under congestion. There are pain and swelling of the organ, pains in the right shoulder, and sometimes down the arm, indigestion, sickness, hiccough, &c., and also fever, which may be slight or severe according to the degree of the inflammatory action. Jaundice is not common, though a slight degree may be present. The movements of breathing increase the pain felt in the side, and this leads to the breathing being short and shallow, and to a short dry cough. No special symptoms indicate the formation of an abscess, though chills and fits of shivering (rigors), occurring in the course of the disease, are strongly suggestive of it. Where the abscess forms in front, a swelling may be evident through the abdominal walls. An abscess is a very serious complication. It may burst into the cavity of the belly, or into the lungs, and be spat up; or it may burst in other directions.

Treatment.—The patient must be kept in bed. The diet must be light and not stimulating—milk, corn-flour, and light soups, fat being removed, &c. Hot applications are to be freely used over the region of the liver. Nothing special can be done for the pains in the shoulder, since with the relief of the liver they will disappear, but not till then. Saline purgatives, as recommended for congestion, are to be employed. The addition to the saline medicine of infusion of senna (2 table-spoonfuls) will help its action. During recovery, change of air, proper food, and the use of dilute nitro-muriatic acid, as recommended for congestion, will be beneficial.

A physician will often advise the opening of an abscess which has formed, and the operation is now performed with great care and success, owing to improved methods of procedure.

The *chronic* form of the disease of the liver is of various kinds. The acute attack above described may end in the chronic disorder, or chronic inflammation may be due to various other diseases. Other forms of chronic disease of the liver are spoken of under CIRRHOSIS.

Its **symptoms** are similar to those already described, but of a milder type.

Its **treatment** is practically the same as that for congestion—plain food, moderate exercise, saline purgatives, and the dilute nitro-muriatic acid, or the chloride of ammonium.

Cirrhosis of the Liver (*Hob-nailed Liver, Gin-drinker's, or Drunkard's Liver*).—The word cirrhosis is derived from the Greek *kirros*, yellowish, because in this disease the liver is of a grayish-yellow colour—the colour of impure bees'-wax. The phrase "hob-nailed" is applied because of the irregular surface of a liver affected with the disease; and the term "gin-drinker's liver" points to the fact that constant spirit-drinking (not necessarily of gin) is one very common cause of the complaint. It sometimes occurs, however, in people quite independently of spirit-drinking, and it has been known to occur in children. Cirrhosis may also, and often does, arise from syphilis.

In the disease the fine connective tissue, running between and acting as a sort of framework for the liver cells (p. 141), increases in amount. The result is slight enlargement of the liver at first, but the newly-formed tissue contracts gradually, until, in the end, the liver is much reduced in size. There is, in fact, **atrophy of the liver.** It is the contraction that produces the irregular surface suggesting the term "hob-nailed." One evil consequence of the growth of this tissue among the cells, and its gradual contraction, is that the cells are pressed upon, so that their normal nourishment is impaired, and they waste and disappear.

The **symptoms** are none of them such that any but experienced persons could trace to their proper cause,—indigestion, loss of strength, growing thinness, sallow complexion. Troublesome piles are common. Sometimes there is

diarrhœa, though sometimes costiveness, and the motions are usually pale. There is never serious jaundice. The occurrence of dropsy of the belly is frequent, as well as the passage of blood from the bowels, because, as the disease progresses, the contraction of the liver hinders the due return of blood to the heart, and thus causes engorgement of the abdominal blood-vessels. The occurrence of abdominal dropsy in a constant drinker should lead one to suspect this disease at once. With these symptoms, percussion (p. 191) shows the liver to be diminished instead of increased in size.

The disease may last for years before it cuts off the patient.

Treatment.—Spirit-drinking must be entirely stopped. It is to be remembered that constant tippling is even worse in the production of the disease than occasionally getting drunk. This is the main point in the treatment. The other treatment to be adopted is practically the same as that already recommended for congestion. Dropsy, bleeding, &c., are to be treated as noted under these diseases.

Inflammation of the Bile-ducts (*Catarrh of the Bile-ducts*).—This is usually a result of cold, and frequently accompanies what has been already described as gastric catarrh, or cold in the stomach.

Its **symptoms** are indistinguishable from those described as belonging to gastric catarrh (p. 158); they are disordered stomach, loss of appetite, flatulence, pain or uneasiness across the belly and towards the right side, sickness, vomiting, white-coated tongue, and fever. The only additional thing is that after some days, perhaps a week or more, jaundice comes on, and there is tenderness or pain over the liver. The first appearance of the yellow tinge of jaundice is to be looked for in the whites of the eyes. The jaundice and pain are both due to the same cause. The bile-ducts are not very wide channels, and the inflammation causes swelling of the lining membrane, and thus blocks the passage. The bile is therefore prevented from flowing into the bowel, and being dammed up in the liver causes swelling and tenderness. The absence of bile in the bowel produces costiveness, flatulence, &c. After a time the bile, failing to escape from the liver, is picked up again by the blood-vessels, gets into the blood, and causes the yellowness of the whites of the eyes and of the skin, and a dark colour of the urine, in which the presence of bile may be detected.

For **treatment**, consult what has been said about gastric catarrh (p. 158), and add to it that hot applications are useful over the liver.

Obstruction of the Bile-ducts may be produced by inflammation, the swelling and thickening blocking the channels. It is often due to gall-stones, which pass down some distance and finally stick altogether, and to various other causes. Some of the smaller ducts in the liver only may be obstructed, or it may be the duct from the gall-bladder. The worst case, of course, is where the hepatic duct (p. 142), or the common bile-duct, is obstructed, since then the bile cannot flow out of the liver at all. In such cases the bile gets pent up in its channels, unable to escape, and as the liver goes on producing bile the liver speedily becomes engorged with bile, and all the channels become widened with the pressure of the fluid. The liver, therefore, gradually enlarges. This goes on for a certain time till the pressure of fluid in the bile-channels becomes so great as to act back on the liver cells. The cells become degenerated in consequence, and the liver gradually ceases to form fresh bile. That which has accumulated becomes changed in character by materials being absorbed, picked out of it, and passed back into the blood. In the end, after several months, the liver shrivels, wastes, and becomes flabby. Death may result from complete obstruction in a few weeks, though life may be prolonged for several years.

The **symptoms** are chiefly intense jaundice, costiveness from the absence of bile in the bowel, the motions being of the colour of clay, inability to digest fat, and various other symptoms described under JAUNDICE (p. 198). The enlarged liver may be felt by the fingers projecting from under cover of the ribs. It is needless to detail symptoms or treatment here, since the case will tax the powers of a skilful physician.

The treatment consists mainly in attending to the general health, avoiding fatty foods and alcohol, taking moderate exercise, &c.

Biliousness is a favourite complaint. Many people, whenever they are troubled with headache, sickness, or vomiting, attribute their illness to "an attack of the bile," whatever that may mean. A man drinks too freely some evening, and rises with a severe headache next morning, or perhaps doesn't rise next morning because of a severe headache. He tells his friends, his business associates, or his employer that he had a "bilious headache." Many who do not know what it is to practise self-restraint in eating,

drinking, or in any other direction, are loud in their complaint of "the bile," that baneful juice that deprives them of all pleasure in life. Biliousness is thus not only a favourite, but also a convenient complaint.

Now it may be that sometimes an excessive amount of bile is poured out of the hepatic duct, which, as we have seen (p. 142), opens into the small intestine a few inches below the stomach. In such a case some of the bile may readily find its way up into the stomach, provoke vomiting, and lead to loss of appetite for a time, because the stomach is unaccustomed to its presence. This is, perhaps, not unlikely to happen after a long fast, during which bile has been formed by the liver and has not been required. The accumulated bile may, therefore, for little reason, discharge itself into the intestine, and meeting with no food to use it, may give rise to so-called bilious symptoms. It may, however, be set down as a rule that this is not a common occurrence. In short, biliousness is simply a common term employed for various and different affections, most of which we have already considered. Thus nausea and sickness, with loss of appetite, a dull headache, and perhaps a slightly yellow tinge of the whites of the eyes, are symptoms akin to those described under CONGESTION OF THE LIVER, and are to be treated as there advised.

Again, many people, specially women, are troubled with regularly recurring attacks of severe headache, with intense sickness and vomiting. The vomit is at first of the contents of the stomach, but is soon tinged with bile, and the attack is at once ascribed to bile. After some hours' or a day's suffering the headache and sickness gradually subside under the influence of quiet rest in bed in a darkened room. The person suffers from the attack every now and again. Now this is not biliousness. It is probably an attack of what has been described on page 112 as sick-headache, or megrim, or brow-ague, and is to be treated as there recommended, with 5 grains of bromide of quinine, or 15 to 20 grains of powdered guarana. The presence of bile in this case is easily accounted for. It only appears after vomiting has occurred once or twice. The pressure exerted on the gall-bladder by the efforts of retching forces the bile into the small intestine and up into the stomach, from which it passes with the vomit. It is not the presence of bile that causes the vomiting; it is the continuance of the vomiting that causes the presence of bile in the stomach.

There are many vague symptoms which people ascribe to biliousness: bad appetite, bad taste in the mouth, irregular or costive bowels, a tendency to dull headache, which may be the symptoms of slow digestion. A saline purgative in early morning, and in general the treatment advocated for indigestion will probably relieve this condition.

To repeat, biliousness is a popular name for a great variety of complaints. By carefully examining the symptoms in the light of what has been here stated one may arrive at an idea of the probable cause of the trouble, and be able to better the condition.

Jaundice (*Icterus*) is probably derived from the French *jaune*, yellow, because of the yellowness of the skin, characteristic of the disease. It is caused by such obstruction as has been already noted, or by a tumour, cancer for example, pressing on and closing the ducts, or by such diseases of the liver as congestion. In these cases the liver forms the bile, which, however, is not permitted to escape into the bowel. In other cases jaundice occurs during the course of some other disorder, such as yellow fever, relapsing fever, and some forms of blood poisoning. It appears that powerful mental emotion may produce it, probably because of spasmodic closure of the bile-ducts.

The **symptoms** are due to the fact that the bile, not being able to pass into the bowel, is absorbed into the blood and distributed throughout the body, staining the tissues through which it passes. The chief is yellowness of the skin, varying from a mere sallowness to a golden yellow or bronze tint. Sometimes in extreme cases the sweat stains the clothes. The urine is coloured also a saffron yellow or a dark greenish colour, or any degree of yellowness between these, owing to the presence of bile. The whites of the eyes are deeply coloured, and in them the first signs of the approaching jaundice may be detected. Along with these are symptoms due to the want of bile in the bowels, costiveness, the motions when passed being pale and like clay in colour, and having a very bad smell, sickness and vomiting, hiccough, flatulence, inability to digest fat, and perhaps the passage of fatty matter in the stools. Resulting from the presence in the blood of improper materials are itching of the skin and perhaps eruptions, feebleness of the heart, exhaustion, drowsiness, giddiness, and lowness of spirits, &c. It is not common for a jaundiced person to see things as if they were yellow, though this is a

popular notion. Jaundice occurring in newly born children is considered under DISEASES OF CHILDREN.

Treatment.—Jaundice arising from congestion of the liver, inflammation of the bile-ducts, &c., must be treated accordingly. Often it will be relieved by 10 grains of calomel, followed by a full dose of castor-oil or senna. Many of the worst cases arising from obstruction are incurable, and the patient must simply take light food without fat or stimulants, must have moderate exercise, and may occasionally take a warm bath to help the skin. But jaundice being a sign of disease rather than a disease in itself, it is necessary to discover its precise cause in order to treat it properly. The difficulties in the way of that are often even too great for educated physicians.

Malignant Jaundice (*Acute Yellow Atrophy of the Liver*).—This is a rare affection, in which the cells of the liver (p. 142) are rapidly destroyed. The disease is usually sudden in its onset, accompanied by jaundice, vomiting, and intense headache, and delirium. A feature of the disease is the absence of bile from the motions. The bile ceases to be formed by the liver. This condition is called **acholia** (Greek *a*, want of, and *cholē*, bile). There is a great tendency to bleeding, blood being poured out in little patches under the skin, and being also vomited. Death may occur within a day, and is seldom delayed beyond a week.

Gall-stones (*Biliary Colic*) are little masses formed of the colouring matter of the bile. They are usually produced in the gall-bladder, probably from stagnation of the bile and consequent deposit of the colouring matter. They are of a dark-brown colour usually, and may be very small, like grains, when they are spoken of as "gravel;" or may attain a variety of size, that of a pea or bean, or even larger. There may be only one stone or several; if several, the stones are not round, but flattened on the sides by contact with one another. A gall-stone may become dislodged from the gall-bladder and proceed to force its way down the cystic duct (p. 142) towards the bowel, and in its progress give rise to the severe pain which is called biliary colic. Gall-stones are more frequent in women than men, and they occur usually after the age of thirty.

Symptoms.—Severe pain comes on suddenly, and may be so intense as to cause the patient to cry out in agony. It is described as cutting or tearing, and is felt in the neighbourhood of the pit of the stomach or navel, and extends lower down and through to the back. It lasts a varying time and then ceases, only probably to return some time later. It thus occurs in spasms. It causes sickness and vomiting, faintness, and often actual fainting. If the gall-stone block the bile-duct, costiveness is likely to arise and the stools to be clay-coloured; and jaundice appears after a day or two. The gall-stone may be arrested in its passage through the bile-duct, and may remain in this position, completely blocking the duct, in which case the symptoms of obstructed bile-duct are developed. The only conclusive evidence that the spasms have been caused by a gall-stone is the finding of a stone in the motions. To effect this the motions must be carefully examined. They should be placed on a fine sieve and washed through with water, so that if they contain a gall-stone it may not escape notice. If the stone have escaped from the bile-ducts into the bowel, it is often two or three days after the last spasm before it is passed in the motions, so that the fæces should be examined for a number of days after the attack has passed. A person who has had one attack of biliary colic is always liable to another.

Treatment is devoted to relieving the pain and relaxing the parts, as much as possible, to aid the passage of the stone. This is accomplished by placing large hot poultices or hot bottles over the belly, and by the use of opium; 1 grain of the latter may be given at a time, repeated as often as may be necessary, the patient being carefully watched to see that too much is not being given. A medical man would be able to relieve the pain more speedily by the injection of $\frac{1}{6}$th of a grain of acetate of morphia under the skin or by the use of chloroform. Painful vomiting may be relieved by draughts of warm water containing a teaspoonful of carbonate of soda to the pint.

The person who has had an attack should endeavour to avoid another by plain food, moderate exercise, and the daily morning use of Carlsbad mineral water or Vichy waters.

Degenerations of the Liver, Fatty Degeneration (*Fatty Liver*).—In this affection the liver cells become crowded with globules of oil, which ultimately increase to such an extent that the cells become sacs of oil. The liver becomes large and pale. Fatty liver will result from overfeeding, especially if fatty food form a large part of the diet. Its occurrence is aided by want of exercise. It is also present in consumption; it may be a result of constant

drinking, or of syphilis and other diseases. It occurs in phosphorus poisoning.

Its **symptoms** are of no special character, so that the recognition of the condition is not easy. Symptoms of chronic indigestion are among its chief signs.

Treatment is similar to that of congestion of the liver (p. 195).

Waxy Liver (*Lardaceous Disease or Amyloid*).—Syphilis and scrofula lead to this degeneration, in which the substance of the liver becomes converted into a dense glistening material like yellow wax. It may result from the presence of any prolonged discharge from some sore or from disease of bone. Its nature and symptoms are too obscure to be treated here. One of its results is that the liver may attain to an enormous size.

Tumours of various kinds occur in the liver. It is only necessary to note the **Hydatid tumour**, described on p. 172, due to a tape-worm, and **cancerous tumours.** The detection of cancer is the work of a skilful physician. Unfortunately nothing can be done for its cure. The patient may have relief from pain, and should have what is needful to maintain as far as possible his strength, but that is all that can be done. Death is seldom later than two years from the beginning of the symptoms, and may be within six months.

DISEASES OF THE PANCREAS.

The pancreas is liable to such diseases as attack other organs—inflammations, abscesses, &c., but little is known concerning them.

Section VII.—THE GLANDULAR AND ABSORBENT SYSTEM.

A.—ITS ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS)

The Lymphatic Vessels and Glands:

The lacteals of the bowel and the nature of the fluid (*chyle*) they contain;
Lymphatic glands—their structure and functions;
The receptaculum chyli and thoracic duct;
Lymphatic vessels, the nature of the fluid (*lymph*) they contain, their function as absorbents, the meaning and importance of absorption.

The Blood or Ductless Glands:

The Spleen;
The Thyroid Gland;
The Thymus Gland;
The Supra-renal Capsules;
The Pituitary and Pineal Glands;
The Glands of Peyer.

The Lymphatic Vessels and Glands: Absorption.

It has been pointed out on pages 144 and 145 that the blood is regularly receiving fresh supplies of material to maintain its bulk and quality from food that has been taken into the alimentary canal. It has been seen that the nourishing portions of the food gain access to the current of blood by two channels, that watery parts of the food, containing sugar, salts, &c., dissolved in them, can pass directly through the walls of the blood-vessels of the mucous membrane of the intestine, and gain entrance to the blood, but that fatty matters cannot so pass. In the small intestine, however, fat is acted on by bile and pancreatic juice, and, as a result of that action, the fat no longer floats in large globules among the food, but is made into a milk-like mixture, and is broken up into a great number of very minute globules. The fat being scattered through the food in this fine state of division gives it a milky appearance, from which it is called **chyle** (Greek *chulos*, juice). The chyle is separated from the contents of the intestinal canal by the villi (p. 140) of the small intestine, which project from the surface of the bowel to suck up the juices it may contain. The sucked-up juices pass into a vessel in the villus. The vessel has been called a **lacteal**, from the Latin word *lac*, milk, because of the milky appearance of the juice it contains. So that the lacteals are the second channel by which nourishing material

passes from the intestinal canal. The process that we thus see performed by blood-vessels and lacteals, by which materials are picked up to be used in the body, is called **absorption** (from Latin *absorbere*, to suck up), and it is a process, as we shall see, not confined to the intestinal canal, but going on in every tissue and organ of the body. The vessels by which the absorption process is carried on are called **absorbents.** We must now follow the course of the chyle in more detail than it was convenient to do on page 145. It appears that this milky fluid which fills the lacteals is not in a proper condition to be poured at once into the current of blood. It may be it is too raw material yet, and must undergo some measure of preparation. The bowel is suspended from the back wall of the belly by means of a double fold of membrane, the mesentery (p. 131). The lacteal vessels are continued up from the bowel between the folds of the mesentery, and pass through glands which are also contained between the folds. [Refer to Fig. 107 and its description.] The glands are called the **lymphatic glands of the mesentery,** or, shortly, the **mesenteric glands.** There are about one hundred and fifty of them. In a healthy state each gland should be about the size of an almond, but in certain diseases they are enlarged, and, as has already been pointed out (p. 165), they are seriously affected in consumption of the bowels. Fig. 108 represents the structure of one of these glands. The gland has an investing coat or capsule (*aa,c*), which completely surrounds it. From the capsule fibrous strands (*b, b*) pass into the gland, dividing it off like partitions into spaces. The spaces round the circumference (or *cortex*) of the gland are of considerable size, and are more or less oval (*d, d, d*), while the spaces towards the centre (or *medulla*) are irregular in shape, and smaller (*e, e*). The spaces are almost completely filled with masses of material, consisting of a net-work of very delicate connective tissue, in which white cells of various sizes are entangled. This sort of tissue is called **adenoid,** or gland tissue, from the Greek *adēn*, a gland. But the masses of tissue do not quite fill the spaces. Between the outer surface of the mass and the wall of the space are channels, and the channel round one mass communicates with that of another, and those round the edge communicate with those in the centre, so that the gland might be looked upon as a mass of gland tissue broken up into numerous little clumps by a series of irregularly winding and communicating channels. The channels, moreover, are not perfect fairways. They are crossed and recrossed by spans of the delicate tissue of the gland, so that the whole structure becomes not unlike that of a sponge. Now the lacteal vessels join the mesenteric gland at the margin or outside (as shown at *f, f*, Fig. 108), and pour their fluid contents into the channels there. From them the fluid filters its way to the channels of the centre, bathing and penetrating the gland tissue in its course, and finally joins vessels, identical with *f, f*, at the centre, by which it is carried away from the gland. The outgoing vessel is represented by *g,h*. In this progress through the gland the chyle undergoes some important changes. Be-

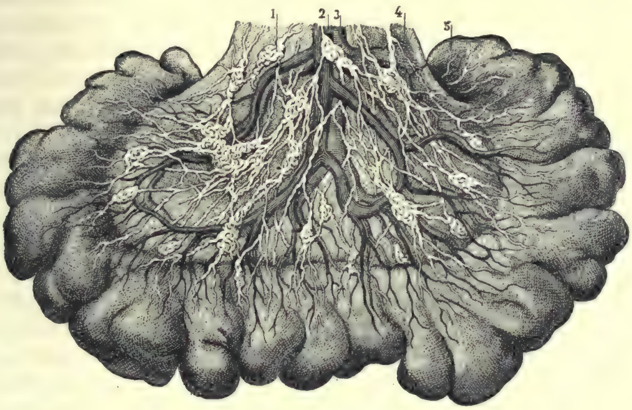


Fig 107.—Mesenteric Glands.

4 points to the membrane of the mesentery from which the bowel (5), seen in folds, is suspended. 1 points to a gland, a large number of which are present, connected to one another and to the bowel by fine lymphatic vessels. 2 indicates a vein, and 3 an artery branching through the mesentery and over the bowel.

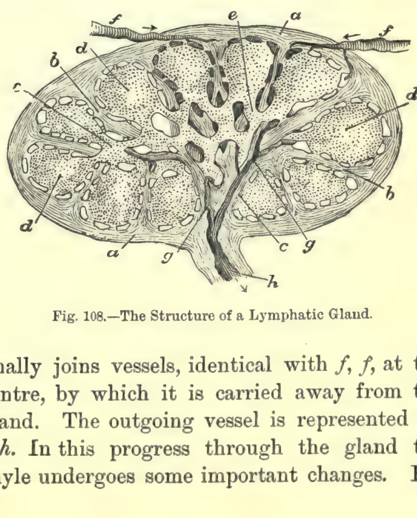


Fig. 108.—The Structure of a Lymphatic Gland.

fore entering the gland it was simply a milky fluid, containing very fine particles of matter in suspension, and being incapable of coagulation, or clotting, when heated; but, on leaving the gland, it is capable of coagulation, and contains numerous white cells, which have been swept away from the gland tissue by the stream. It will now be evident how liable the lymphatic glands are to be irritated and thrown into a condition of inflammation. Suppose the ingoing vessels carry with them irritating material, it filters through the whole gland, irritating in all its course, and swelling and inflammation result. Sometimes this may save the rest of the body. It may be that the gland not infrequently intercepts, like a filter, material which, if permitted to go on, and finally to pass into the blood, would affect the whole body, but which, caught by the gland, expends its whole force on it, so that while the gland suffers the rest of the body escapes. Having issued from the gland, the chyle flows onward in lacteals in the mesentery till it is poured into the receptacle for the chyle—**receptaculum chyli** (2, Fig. 109). This receptacle is a sac-like expansion at the lower end of a duct—the **thoracic duct** (1, Fig. 109). Not only do all the lacteal vessels pour their contents into the receptacle, but other vessels—lymphatic vessels of the lower limbs, to be described immediately—also join it. It lies on the front of the spinal column at the level of the upper lumbar vertebræ (p. 20). From the receptaculum chyli the thoracic duct passes upwards along the front of the spine through the cavity of the chest to the root of the neck. Here it curves forwards and joins a large vein from the neck—the internal jugular—just where that vein joins a large one from the arm (3, Fig. 109). So that the chyle, after passing through the mesenteric glands, is carried up to the root of the neck by the duct, and there poured into the blood. The thoracic duct is from 15 to 18 inches long, and about the size of a small crow-quill.

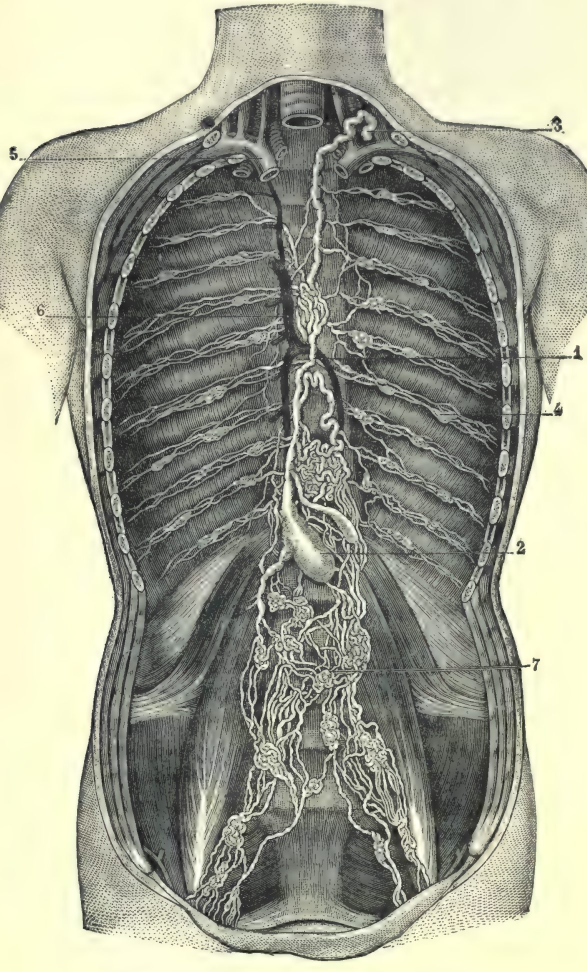


Fig. 109.—The Thoracic Duct and Lymphatic Vessels.

In the course of the lacteal vessels and thoracic duct there are valves which direct the flow of fluid and prevent it passing backwards, while a valve at the junction of the duct and the veins in the neck permits the contents of the thoracic duct to flow into the vein, but prevents the blood passing from the vein into the duct.

Fig. 109 shows the course of the thoracic duct. Lymphatic vessels are seen joining it from below, and from the walls of the chest. Glands are shown in the course of the vessels, 4 pointing to a gland of the chest wall. 5 and 6 point to veins.

Now in every organ and tissue there is a set of vessels, called **lymphatic vessels,** precisely

similar to the lacteal vessels of the mesentery; and they are connected with lymphatic glands just as the lacteals are connected with mesenteric glands. These lymphatic vessels contain a fluid called **lymph**. What lymph is must be properly understood. The blood flows through the whole body, being distributed in small vessels with extremely thin walls. As the blood flows in these fine vessels through a muscle, for example, it oozes through the delicate walls, so that the fibres of the muscle are bathed in the fluid, and the muscle can select the nourishment which it requires. Just as a river flowing through a large plain may be made to water the whole of it, by a set of channels being cut here and there throughout it, along which the water may be caused to flow, and be thus brought near every part of the fields. It is the presence of lymph among the tissues that gives to them their softness and moisture. More fluid escapes from the blood-vessels than may be necessary for the nourishment of the tissues. The excess must be removed. It passes into the lymphatic vessels which abound in muscle. Since the fluid has bathed the tissue, it will have picked up materials from the muscle, principally waste substances which have been produced by muscular work. This excess of nourishment, along with the waste substance removed with it from the tissues, forms lymph. The lymph is not cast out of the body; it is returned to the blood. But even as the chyle from the intestine was not in a fit condition for immediately joining the blood-stream, and was passed through the mesenteric glands to be properly worked up, so the lymph is carried to lymphatic glands, where it undergoes certain processes to fit it for being poured into the blood. Here, then, is another example of the marked economy exhibited in the body. Nothing is cast out in the ordinary healthy body that can be of further service in the system. As to the characters of lymph, they resemble those of chyle. It is a whitish fluid, slightly yellowish, clots readily, and contains white cells, like the white cells of the blood, but it does not contain the minute globules of fat that abound in chyle.

It has been said that lymphatic channels exist in every organ and tissue of the body; and perhaps it will give some idea of their abundance when it is said that it has been estimated that the quantity of fluid picked up from the tissues by their agency and restored to the circulation in 24 hours is equal to the bulk of all the blood in the body. The lymphatic vessels unite to form larger and larger vessels, and in the end join the thoracic duct, with the exception of the lymphatics of the right side of the head and chest and right arm. These latter form a short wide trunk—the **right lymphatic duct**—which opens into the junction of the jugular vein of the right side, coming from the head, with the vein coming from the right arm, a similar position to that of the thoracic duct on the left side. In Fig. 109, 5 points to the vein formed by the junction of the veins of the head and arm. Thus all the lymphatic vessels of the lower limbs, of the belly, of the left arm, and of the left side of the head and chest, and all the lacteal vessels from the intestine, pour their contents into the thoracic duct, while the lymphatics of the rest of the body join the right lymphatic duct.

Now it is easy to fail to estimate the importance of the lymphatic system, and perhaps its significance will be best understood by a few examples. Let it be repeated that lymphatic channels exist in every organ and tissue; they abound in the skin. Now suppose a pin or some sharp instrument with a dirty point is introduced into the skin. The poisonous material left among the moist tissues cannot fail to be carried with the lymph into a lymphatic channel. It will be carried to a lymphatic gland, and may be there intercepted, or may filter through the gland and gain access to the blood. All this may happen in a very short time, and thus it is evident how blood-poisoning may be the result of a very small wound. Even though the material introduced into the skin be not sufficient in quantity or in violence to poison the blood, it may produce other effects. It may irritate the vessels along which it is carried, and inflammation result; and then the presence of lymphatics in the skin is speedily revealed by the appearance of fine red lines, painful to the touch, which mark the track of the inflamed vessels, while the skin in the neighbourhood of the vessels is swollen and glazed. In the same way the poison may act upon the gland. It sometimes seems to spend its strength on the gland, which becomes inflamed, swollen, and in the end an abscess may be formed, or, even if that does not result, a hard swollen mass remains to mark the attack.

Take another example,—the occurrence of hard, swollen glands, popularly called "**kernels,**" is common in children, particularly at the side of the jaw and in the neighbourhood of the ear. Of course something may have directly injured the gland to make it swell in this way, but if

what has been said has been understood, it will at once occur to anyone that the swelling of the gland may be due to some irritating matter brought to it by a lymphatic vessel from some part a little removed from the gland. Under such circumstances, if one knows from what part of the body the lymphatic gland receives its lymphatic vessels, one may examine the whole district to see if in any part of it some irritation is present to account for the enlarged gland. This will be again referred to in speaking of inflammation of glands.

Advantage is taken of the absorbing power of the lymphatics to introduce medicines into the system. When ointment is rubbed into the skin, it is no doubt by means of the absorbent vessels that part of it is picked up and carried into the blood. The skin of some animals absorbs very readily, that of man not so readily. Still, experiment has shown that a person placed in a bath will absorb some water by the skin, and, if carefully weighed, he will be found heavier on leaving the bath than before entering it. Efforts have been made to nourish persons, who could not take food by the mouth, by means of milk baths, &c., though, from the comparatively small amount taken up, the success has not been great. Another method of administering medicines depends on the absorbing power of the skin and tissues beneath it, the method of *hypodermic* injection (Greek *hupo*, under, and *derma*, the skin). It consists in thrusting the point of a hollow needle under the skin. The needle is connected with a small syringe containing a drug in solution. When the piston of the syringe is pushed down, the fluid is forced along the hollow needle into the tissues under the skin, from which it is rapidly sucked up by the absorbent vessels and passed into the blood. Solutions of morphia are given in this way for the relief of pain. The speed of absorption is shown by the fact that within two or three minutes, sometimes indeed within a few seconds, after the injection, the pain in many cases vanishes. Again, every smoker knows that if he draws the smoke of tobacco into his lungs, he will speedily feel its effects in his head. The moist membrane of the lungs has seized upon the vapour, and its elements have been absorbed by the lymphatics, and, reaching the brain by the blood, have produced their characteristic effects. Absorption by the bowels, absorption by the skin, and absorption by the lungs are thus facts of very great importance in the body. Let it be remembered that in each case the materials sucked up are passed through glands to be worked up into a fit state for entering the blood.

Blood Glands.

Along with the lymphatic glands there is classified a number of organs called **blood glands**, because, like the lymphatic glands, they are supposed to have something to do in preparing material for the blood. They are also called **ductless glands**, because, though apparently organs for preparing materials to be of use in the body, they have no ducts or canals along which any material they may prepare may be conveyed away.

The **Spleen** is the chief of these. It is situated in the belly to the left side of the stomach in the hypochondriac region (p. 131). Its position in reference to the stomach is well shown in Fig. 96, p. 142, and by studying this figure in conjunction with Fig. 91, p. 132, a good idea may be obtained of its position in reference to the rest of the body. The spleen is popularly called "the melt." It weighs usually from 5 to 7 ounces, is an elongated, flattened body, 4 to 5 inches in length, and 3 inches broad. It is usually of a deep red or a purplish colour. It is a gland of considerable importance, if we are to judge of its blood supply, for it receives an artery—the **splenic artery**—directly from the aorta, the chief blood-vessel of the body.

Its vein—the **splenic vein**—joins the portal vein, as we have already noted on p. 140. Its structure much resembles that of a lymphatic gland, already described. It has a fibrous capsule, from which partitions, or trabeculæ, pass inwards, dividing off the organ into spaces by the irregular net-work they form. In these spaces is inclosed **spleen pulp**, which consists of cellular bodies of various sizes—some like the white corpuscles of the blood, some larger, and others smaller. If a spleen be cut open and looked at with the naked eye, small white round bodies, like sago grains, are seen scattered through it. These are the **corpuscles of the spleen**, or the **Malpighian bodies of the spleen**. They are masses of what has been called adenoid tissue (see p. 201), consisting of white cells in a net-work of fine fibres, and through each body passes a branch of the splenic artery. Fig. 110 shows a

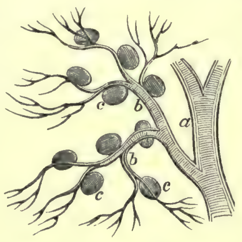


Fig. 110.—Portion of Splenic Artery, with Corpuscles of the Spleen attached to its twigs.

branch of the splenic artery (*a*), with the corpuscles (*c*) situated on its twigs (*b*). The blood passes from the capillaries of the artery into fine spaces among the spleen pulp, from these to larger spaces, and then on to the veins, which carry it away from the organ. In fact the spaces are of such a character that the blood from the artery filters through the pulp, just as fluid would pass through a sponge, and is then collected by the veins.

Functions of the spleen.—Such a remarkable structure suggests that the business of the spleen is to affect in some way the quality of the blood. As the blood filters through the spongy pulp, it may be that some important change is wrought in it by the active cells of the pulp, either, as some hold, in the way of removing from the blood-current old and worked-out red cells, or, as others believe, in the direction of adding to the blood new and active white cells, for the white cells of the spleen are not distinguishable from those of the blood. The blood coming from the spleen is said to be richer in white cells and poorer in red ones. It has been found that the spleen increases in size after a meal, being considerably swollen five hours after a meal, remaining so for some time, and then returning to its usual size. So that it undergoes a regular alternate expansion and diminution in size. When, however, it is mentioned that the spleen has been wholly removed from an animal without any apparent effect, it will be understood how vague and obscure is yet the question of its function. An old view, not now maintained, was that the spleen acted as a sort of overflow reservoir to the liver, so that, when the liver became engorged, the spleen received an extra quantity of blood, distended readily owing to its spongy nature, and thus acted as a sort of safety-valve to the liver when any temporary obstruction to the passage of blood, through the portal vein, threatened danger to that organ.

In ague and other malarial diseases the spleen becomes remarkably enlarged; and there is also great enlargement in a disease called **leucocythæmia**, in which the number of white corpuscles of the blood is enormously increased. This is referred to under DISEASES OF THE BLOOD.

The **Thyroid Gland** is another of the ductless or blood glands. It is situated in the neck, and consists of two lobes or divisions, one on each side of the box of the windpipe, the two being connected by a cross-piece. It is usually larger in the female than in the male. Its position may be seen by reference to Fig. 116 on p. 219. It consists of a capsule, sending in partitions which divide off the gland into spaces, occupied by round or oval sacs or vesicles, which are lined with cells and filled with glairy contents. The gland is richly supplied with blood-vessels. Of its functions nothing is precisely known, though it is supposed, like the spleen, to have something to do with the destruction of worn-out blood corpuscles. It is of interest because a great enlargement of it is the feature in **goitre** (*Derbyshire neck*), and a peculiar form of idiocy, called **cretinism**, is associated with it. Both of these diseases are discussed at pages 210, 211.

The **Thymus Gland** also belongs to the blood glands. It also is placed on the windpipe, but lower down than the thyroid, being in the upper part of the chest, behind the top of the breast-bone. It is in its period of greatest activity before birth, beginning to waste away soon after birth. Gradually the greater part of the gland disappears, its place being taken by connective tissue and fat, so that with the end of childhood little of it remains. It consists, like the lymphatic gland, of spaces inclosing adenoid tissue (p. 201). It is supposed to have to do with the elaboration of the blood, but nothing definite is known of its functions.

The **Supra-renal Capsules** are two small bodies connected with the kidneys. They are in shape not unlike a cocked-hat, and one surmounts each kidney. They are large before birth. In structure they are peculiar. The fibrous covering of the gland gives off divisions, which pass inwards, dividing it off into spaces, some of which are circular, some oval, and some small and irregular. These spaces are filled with masses of large epithelial cells (p. 16). The blood-vessels ramifying between the groups of cells are very numerous, so also are the nerves. Of their function nothing is known, though they are usually classed with the thyroid, thymus, and other blood glands. But there is a disease, called **Addison's disease**, in which there is deep bronzing of the skin, supposed to be connected with diseased conditions of the supra-renal bodies. This disease is commented on at p. 212.

The **Pituitary and Pineal Glands** are small bodies situated towards the base of the brain. The pituitary body is called from *pituita*, Latin for phlegm, because it was supposed by the ancients to discharge phlegm or mucus down

the nostrils. The pineal gland is a small body about the size of a cherry-stone, and is called from *pinea,* a pine. It is placed in front of the corpora quadrigemina (p. 90). Both of them are formed of epithelial cells. They have been classified as blood glands, without anything definite being known regarding them.

Peyer's Glands have been already mentioned as occurring in the mucous membrane of the intestine, sometimes singly, sometimes in groups (p. 140). They are small, round, shut sacs, composed of a fibrous tissue capsule, and containing the same sort of tissue as the lymphatic gland. They are affected in typhoid fever. Because of their resemblance in structure, they are classed with the blood glands, nothing being known of their functions.

SECTION VII.—THE GLANDULAR AND ABSORBENT SYSTEM.

B.—ITS DISEASES AND INJURIES.

Diseases of Lymphatic Vessels and Glands:
Inflammation of lymphatic vessels (*Lymphangitis, Angioleucitis*);
Inflammation of lymphatic glands (*Adenitis*)—kernels;
Lymphatic Tumours (*Lymphoma, Lymphadenoma* or *Hodgkin's Disease*).
Diseases connected with the Spleen:
Congestion, Enlargement, &c.
Diseases connected with the Thyroid Gland:
Goitre (*Bronchocele, Derbyshire Neck*);
Exophthalmic Goitre (*Graves'* or *Basedow's Disease*);
Cretinism.
Disease connected with the Supra-renal Capsules:
Addison's Disease.

DISEASES OF LYMPHATIC VESSELS AND GLANDS.

Inflammation of Lymphatic Vessels (*Lymphangitis,* also called *Angioleucitis,* from Greek *angeion,* a vessel, and *leukos,* white).—This most commonly results from the introduction under the skin of some irritating material, which, as explained on p. 203, is picked up by the lymphatic vessels, and subsequently irritates them. Medical men and students run risks of it, coming in contact as they do with so many foul discharges. The smallest break in the skin, even that made by a pin point, may afford entrance to poisonous stuff, which begins to manifest its presence within a few hours after its introduction. Injury may also set up the inflammation.

Symptoms.—The chief evidence of the disease is the presence of fine red lines in the skin. These mark out the course of the inflamed vessels. They may be traced from the place where the irritating substance has been introduced, the neighbourhood of which place is likely swollen, the skin being tight, glazed, and with a deep flush, and their course followed up to the lymphatic gland which the vessels join. Thus, suppose some irritating material, say irritating matter from some bad sore, to have gained entrance at the point of the thumb. After some hours the thumb will begin to feel stiff and painful, and will be evidently swollen and hot. As the inflammation develops, the swelling, tenderness, and redness will increase, and the redness will be specially noticed as a sort of broad band down the front of the thumb. This broad red band will be traced over to the wrist, where there is likely to be a specially swollen clump, the meeting-place of several lymphatic vessels. From the wrist bright red streaks will be seen passing upwards to the inner side of the elbow, where there is likely to be a sore spot, and perhaps they pass still upwards to the arm-pit and inflame the glands there. This is the direction the lymphatic vessels take, as may be seen from Fig. 112. The red streaks are hard and painful when touched. As the inflammation goes on they broaden, till neighbouring streaks meet, and thus a great extent of the limb, or even the whole of it, may become swollen and painful. If the inflammation be severe, the patient is likely to have chills and shivering fits (rigors), and there are probably fever, sickness, and prostration. It may lead to the formation of matter in the course of the vessels, or may set up inflammation in a lymphatic gland, ending in abscess. The worst

result is where the poison passes beyond the gland and sets up blood-poisoning (septicæmia or pyæmia), in which case death may result from the violence of the poison within a few hours. In simple cases the inflammation is expended on the vessels and on the gland, and slowly subsides after attaining its height.

Treatment.—The affected part must be kept at perfect rest. This can be properly managed only by the patient staying in bed. Warm applications are to be kept to the inflamed region. At once a large dose of saline medicine must be given, such as Epsom-salts, seidlitz-powders, &c., so that a speedy and copious discharge from the bowels is obtained. These are the first and simple means to be adopted, and in uncomplicated cases are sufficient. Nevertheless, as one cannot at first judge how serious the case may turn out to be, and, as within a few hours an apparently simple case may show evidences of threatening life, a medical man should at once be consulted. If that is not possible, and the fever be considerable, 5-grain doses of quinine every four or six hours should be administered, and the patient should have as a drink 120 grains of chlorate of potash dissolved in a pint of barley-water or lemonade, to be drunk within twenty-four hours. Strengthening food is of the utmost consequence in severe cases. (Refer to Blood-poisoning, p. 236.)

It is evident that since this disease is usually due to the introduction of poisonous material, great care should be exercised in its prevention. For this purpose, if one has received a wound from an instrument whose cleanness is suspected, or has a wound—a prick with a sharp instrument, a cut, a scratch, &c.—into which some poisonous stuff has been introduced, the part should be immediately grasped tightly nearer to the heart than the wound, so as to stop the circulation of blood in the part, the lips should be at once applied to the wound, so that it may be sucked vigorously to remove the poison, and as soon as possible a stream of pure water should be run upon it to wash it thoroughly. Not till this has been done should the grasp on the part be released, and by this time probably all injurious material has been removed. If these precautions are promptly and vigorously taken, no further treatment is likely to be necessary, unless covering the wound till it is healed, to prevent the entrance of any irritating substance at a later period.

Inflammation of the Lymphatic Glands (*Adenitis*, from Greek *adēn*, a gland).—As has been pointed out in the preceding paragraphs, this is a frequent result of inflammation of lymphatic vessels, owing to the same substance that irritates and inflames the vessels being carried to the gland. Of course, in such cases, the cause of the glandular affection is obvious, because there is the preceding inflammation of the vessels. In many cases, however, a gland may become inflamed and swell without any previous indications of the disease proceeding onwards in the track of the vessels. They have conveyed material to the gland which has irritated it, while they themselves have escaped. Thus swellings of glands are common in children in the neighbourhood of the jaw, behind the ear, and towards the back of the head. These are frequently due to the chronic irritation of eruptions about the face or head, running ears, or scabs and sores on the head. In some cases a row of hard enlarged glands behind the ear towards the back of the neck is the first indication of sores on the head to which no attention had been paid. Lymphatic glands may, however, become inflamed from other causes than these. Injury may be the cause. Again, the glands may inflame in the course of other diseases, such as measles, scarlet fever, &c.; while affections of the lymphatic glands are the troublesome occurrences in scrofula (king's-evil), and such constitutional diseases.

Symptoms.—The disease occurs in an *acute* and a *chronic* form, and the symptoms vary accordingly.

In the *acute* attack there is some fever, preceded by shivering, the gland becomes swollen, hard, hot, and painful, and the surrounding parts usually also become swollen and tender. If matter forms the hardness yields, and the gland gives to the fingers a peculiar feeling that indicates fluid matter within it.

In the *chronic* variety the pain and heat are less, perhaps absent, the surrounding parts are unaffected, and the noticeable feature is the presence of the hard, enlarged gland (**kernel**) freely movable under the skin.

Treatment.—It ought to be perfectly clear that the first thing to be done is to discover, as exactly as possible, what is the cause of the inflamed gland. It is of the utmost consequence to find out if the inflammation is due to irritating matter being carried to it from some neighbouring part. Because if this is the cause it is useless to treat the gland so long as the irritation is not removed. The probability is that if the supply of the substance producing the mischief is cut off, the gland will begin at

once to recover itself. It becomes, therefore, a very important thing to notice from what parts of the body certain lymphatic glands, which

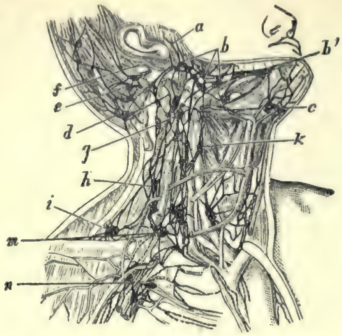


Fig. 111.—Lymphatic Glands of Head and Neck.

Glands in front of and below the ear, *a*, *b*, under the jaw, *b'*, under the chin, *c*, behind the ear, *e*, *f*, at the back of the head, *d*, in the neck and above the collar-bone, *g*, *h*, *i*, *k*, *m*, on the chest, *n*. The dark lines are communicating lymphatic vessels.

are most commonly affected, receive their supplies by lymphatic vessels, so that, when any of these glands is affected, the whole district of the body in connection with it may be scrutinized to find if any source of irritation be present. To aid in this search the following woodcuts have been introduced. Fig. 111 shows the glands of the head and neck. [Distinction must be made between the lymphatic glands of this region and the salivary glands, which have been described on p. 137, and their positions indicated in Fig. 90, inflammation of which is called mumps (p. 153).] The glands in the immediate neighbourhood of the ear and those at the back of the head are to be noticed, as well as

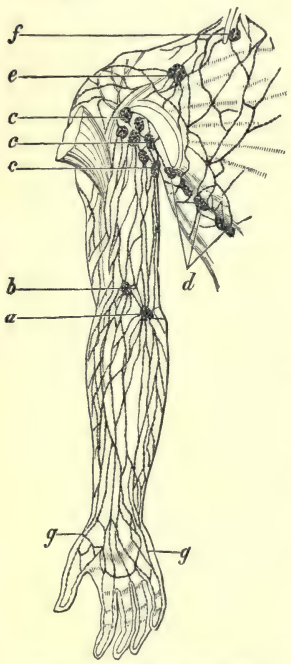


Fig. 112.—Lymphatics of the Arm and Arm-pit.

Glands at the inner side of the elbow, *a*, *b*, in the arm-pit, *c*, *c*, *c*, on the chest in front of the arm-pit, *d*, above the collar-bone and communicating with the arm-pit, *e*, *f*. *g*, *g* point to lymphatic vessels forming an arch round the hand. The dark lines are lymphatic vessels.

those under the chin and the chain of glands passing down the neck. This chain communicates with those of the arm-pit (Fig. 112), so that a diseased condition of the former may be passed down to the arm-pit. Now if glands near the ear be affected, examine the ear and parts in front for the cause; if those at the back of the head, carefully investigate the state of the head up to the crown for scabs, sores, &c. Eruptions on the head are almost certain to be attended by swelling of these glands. If those under the chin are inflamed, examine the mouth, the condition of the teeth, and so on. Attention to a discharging ear, cleaning sores on the head, removing scabs by warm applications, bathing with warm water, treating any skin eruption that may be present, removal of decayed teeth, &c., may be quite sufficient to arrest the affection of the gland and promote its recovery. Fig. 112 shows the lymphatic vessels and glands of the arm and arm-pit. Note that the lymphatic vessels of the hand and arm pass to glands at the back fold of the arm-pit, while the fold towards the chest has a row of glands connected with the chest. If any of the former is affected, see that any bad condition of the arm, hand, or fingers is attended to. An irritable finger-nail may be the whole cause of the trouble. In Fig. 113 are exhibited the glands of the groin. There is a double row of them, one in the line of the groin, the other below them in the upper part of the thigh. The latter receive lymphatic vessels from the leg and foot. An irritable toe-nail may irritate them. The former are connected with the private parts, the genital

Fig. 113.—Lymphatic Vessels of Leg and Groin, and Glands of the Groin.

Chain of glands above the groin, *d*, *e*, *f*, below the groin in front of the thigh, *a*, *b*, *c*. The dark lines are the lymphatic vessels.

organs, and the region of the anus. Hacks or sores about these parts readily cause enlargement and inflammation of the glands of the groin.

This is the first part of the treatment,—*remove any source of irritation to the gland.* If the disease be but beginning, do nothing else; in particular, *do not rub the gland, otherwise it may be worried into producing matter;* only let the part be kept *moderately* warm and protected from all rough usage by rubbing, fingering, or otherwise. Should the inflammation develop, still do not rub, nor apply any stimulating liniments to the part. That can only increase the inflammation. Soothing applications must be the rule. For this purpose apply cloths wrung out of warm water. Give the patient a dose of castor-oil, seidlitz, or citrated magnesia (effervescing), so as to open the bowels freely. Light nourishing diet, particularly milk food, is proper. The inflammation may lessen and promise to pass off without matter being formed. Aid this result by keeping the person quiet, by applying the warm cloths occasionally, and by putting on a light flannel cloth between the times of using the warm applications, and by still an occasional dose of medicine. Often, however, matter is produced, and an abscess formed in the gland. *This must be opened by a surgeon to let the matter out.* Let no mistake be made about this. Very many people strongly object to an abscess about the face or neck being opened by a surgeon. They prefer to let it burst. They seem to imagine that, if opened with a surgeon's lancet, it will take longer to heal or leave a worse mark than if it is poulticed and allowed to open by its own processes. It would be difficult to discover any reason for this idea, which, it ought to be said plainly, is utterly false and absurd. Suppose it is necessary to make an opening in a sheet of glass, nobody would be mad enough to imagine that the safest way was to dash his fist through it, or to throw a stone through it, or to break the hole in it by a strong pressure against it from one side. Everyone would at once say, let a glazier be got, and let him cut the piece out with a diamond. In that way a clean cut would be made, while in any other way there would be the certainty of a star-shaped or ragged hole, and the risk of destruction of the glass. Now it is precisely the same with the collection of matter in the gland. It must be got out. If it is left to burst, the matter goes on collecting; it cannot at once break through healthy skin. More and more collects until the skin is stretched, and itself becomes more or less inflamed with the pressure on it from within. By-and-by the skin becomes undermined and thinned, and at last, when it has become so injured by the pressure and inflammatory process, and so softened that it cannot hold against the pressure any longer, it gives way, and instead of a clean opening, a ragged, irregular tear is produced. Matter comes oozing away for a considerable time, and at last, when it heals, an ugly livid scar is left to mark the place. If, however, as soon as matter forms, a clean cut is made through the still healthy skin, the matter thoroughly cleaned out, and the wound properly closed, no further trouble should arise, and a fine line, which might be a wrinkle in the skin, should alone remain, a scarcely noticeable sign of what has been done. It is quite true that doctors often open such abscesses without getting them to heal quickly. From the wound matter proceeds for days and weeks, and finally a bad mark is left. The parents or friends of the child complain loudly, blame the doctor, and on the basis of their small experience assert the abscess ought never to have been opened. But in the majority of cases the reason is that the doctor has not been consulted early enough. The parents or guardians have tried their own hand first, and usually only after delay, and after the part has been worried by the attempts made to set it right, is the case brought to a surgeon. If the inflamed gland is to be treated with success it must be properly treated from the first; and if an abscess is to leave no mark, the matter must be afforded a way of escape as soon as it has formed.

The treatment for chronic cases consists in treating the scrofular or other constitutional condition which maintains the gland affection. The treatment is mainly good nourishing food, sea-bathing if possible, and the use of cod-liver oil, chemical food, or syrup of the iodide of iron, of which half a tea-spoonful is an ordinary dose. In such cases applications to the gland itself are not desirable. Often, however, the gland is quite destroyed and its place occupied by masses of cheesy matter, or unhealthy-looking ulcers are the result of the disease. All such unhealthy material should be scraped away by a surgeon.

Lymphatic Tumours.—The lymphatic glands are liable to increase of size from excessive growth of the adenoid tissue of which they are composed (see p. 201). This occurs in

Leucocythæmia (see page 235). **Lymphoma** and **lymphadenoma** (*Hodgkin's Disease*) are terms applied to some forms of lymphatic tumours. They cannot be considered in such a work as this. It is, however, of importance to notice that cancer speedily affects the lymphatic glands, and thus a cancerous tumour, which is at first a local disease, that is, affects only the place in which it is situated, spreads by particles of it being carried by lymphatic vessels to glands in the neighbourhood. From the glands it spreads onwards till the local disease becomes a constitutional affection. Now this is of the utmost consequence to notice, because while the disease is still local it may be curable, only, however, if the tumour be completely removed by a surgeon. If, however, the diseased part has not been cut out, but has been allowed to extend so as to infect the glands, the time most favourable for operation is past. Therefore the earliest possible operation for the removal of a cancerous tumour is necessary, and no consideration should be permitted to encourage delay as soon as a qualified surgeon has given his opinion that the disease is cancer and should be removed. Of course it becomes evident that a case of cancer in some of the abdominal organs cannot thus be interfered with, and so the disease rapidly spreads among the glands of the bowel.

Diseases connected with the Spleen.

The spleen is undoubtedly affected by diseases common to other organs, such as congestion, overgrowth, tumours, &c. &c. But the symptoms of such affections are too vague and the results too uncertain to be dwelt on here.

Enlargement of the Spleen is a common feature in cases of ague, which is discussed among Fevers, and in the disease called leucocythæmia, referred to under Diseases of the Circulatory System, p. 235.

Diseases Connected with the Thyroid Gland.

Goitre (*Bronchocele, Derbyshire Neck*) is the chief disease of the thyroid gland (p. 205). It consists of an enlargement of the gland, sometimes a uniform enlargement of all its substance, sometimes an excessive growth of some part of its ordinary structure. The amount of enlargement varies from a mere extra fulness in the front of the neck to an enormous growth hanging down over the chest. It is commoner in females than in males, and occurs rather between the ages of eight and twenty. It is a disease which may be found anywhere, but is endemic, that is, common among the people living in a certain district. Thus in England it is common in Derbyshire, and is hence called *Derbyshire neck*. In Yorkshire, Hampshire, Sussex, and Nottinghamshire, in the Swiss valleys, among the Alps, Himalayas, Andes, and in the Green Mountain region of Vermont in America it is also common. Its frequent occurrence in such districts is ascribed to some malarious tendency, and specially to the nature of the drinking water. An excess of lime salts in the water, particularly carbonate of lime, is held to be the chief cause of its production. People coming into a goitrous district, who stay in it for a sufficient length of time, are liable to be affected, while children of people who have the disease, and who are removed from the place, cease to be liable. The disease is not, therefore, hereditary, but peculiar to the locality.

Its **symptoms** are those of a tumour situated in the lower part of the front of the neck, in front of the windpipe. The tumour goes on enlarging, usually without pain. Any other symptoms are such as would naturally result from the presence in that region of a tumour of any size, symptoms due to pressure. The pressure on the windpipe may obstruct the passage of air by compressing the tube. The gullet behind may be compressed. Veins may be pressed upon, and nerves. The danger of compressing nerves is specially great, since the nerves proceeding to the windpipe are liable to be involved, and the irritation produced may lead to spasmodic closure of the windpipe and sudden suffocation, or suffocation may arise from gradual closure of the tube by the gradual compression. Even when the tumour is of moderate size, headaches, some difficulty of breathing, and tendency to congestion in the head are signs of the pressure produced by it.

Treatment.—The first thing to be done is to have the patient removed, if possible, from the goitrous district to the sea-coast. If this be impossible, at least efforts may be made to diminish the tendency to goitre by purifying the drinking water, which seems to be the chief agent in the disease. If it contain excess of carbonate of lime, this may be got rid of by boiling the water. Carbonic acid is driven off, and the lime in combination with it falls to the bottom, so that the clear water may be decanted off. Shaking it up with air will render it palatable for drinking. Clark's process for

ridding water of excess of carbonate of lime consists in adding lime to the water. This unites with the excess of carbonic acid in the water to form carbonate of lime, which falls to the bottom along with the carbonate previously held in solution in the water. The water may also be purified from salts by distillation. But this process removes all the salts from the water, and makes it very tasteless, which is not desirable.

As regards medicines for the treatment of goitre, the chief is iodine, given as iodide of potassium in doses of 2 to 20 grains according to age and the way in which it is tolerated by the patient. It should be given twice or thrice daily, simply dissolved in water. Along with it there may be conjoined the use of iodine liniment painted over the enlarged gland occasionally, but not often enough to irritate the skin.

The treatment by "burnt sponge" is the same as that by iodine. It seems to be the iodine in the "burnt sponge" that is the efficient ingredient.

In India an ointment of mercury is used. It is made by melting one pound of lard or mutton suet, which, when melted, is cleaned, strained, and then allowed to cool. When it is nearly cold, 180 grains of the biniodide of mercury, ground into a very fine powder, are mixed with it in a mortar till the red powder is uniformly distributed through the lard and no grains are visible. The ointment is kept in pots, protected from the light. It is used in the following way: At sunrise the ointment is applied to the swelling by means of an ivory spatula, and is well rubbed in for at least ten minutes. "The patient then sits with the goitre held up to the sun as long as he can endure it. In six or eight hours there will probably be some pain from the blistering action of the application." The application is repeated at about two in the afternoon, the ointment being lightly rubbed in this time, and is allowed to remain for several days. In ordinary cases one treatment of this kind is sufficient, but if necessary it may be repeated in six or twelve months. When a strong sun is not obtainable a very hot fire may act as its substitute, the patient sitting before it. The same ointment may be employed by rubbing it in, morning and evening, for several days.

It is not considered justifiable to have the tumour removed by an operation, and that for various reasons, among them because of the extensive blood supply to the gland, and the way in which this is increased in enlargement of the gland. Cysts, abscesses, &c., that may form in the gland are opened, often with great relief to the patient.

Exophthalmic Goitre (*Graves' Disease, Basedow's Disease*) is a disease in which enlargement of the thyroid gland, great prominence of the eyeballs (*exophthalmos*, from Greek *ex*, out, and *ophthalmos*, the eye), and extreme palpitation are the special features. The disturbance of the heart and the protrusion of the eyeballs may, however, exist without the thyroid enlargement. Indeed it is not known what is the true cause or nature of the disease. It occurs usually in young women after puberty, and commonly in pale, nervous subjects. Indeed some believe the disease is at first due to some bad condition of the sympathetic nervous system (see p. 98).

The **symptoms** are chiefly those already mentioned connected with the heart, the eyes, and the thyroid gland. Other symptoms are common—disturbances of the digestive system, irritability of temper, feverishness, sleeplessness, and irregularity of the monthly periods. The person's eyes are easily fatigued, and motes are seen passing before the sight.

The proper **treatment** is doubtful. All that is of advantage to note here is that marked benefit has been derived from the administration of 5 drops of tincture of belladonna every hour. How long this should be continued depends on the relief experienced. It may, however, take several days before the relief from its use is obtained.

Cretinism is a form of idiocy associated with a peculiar condition of the body. It is mentioned here because it is associated with goitre, and seems to be due to the same cause. Cretins are usually affected with goitre, and are numerous in districts where goitre prevails. Moreover, cretinous children are usually the offspring of goitrous parents. Cretins are ill-grown and stunted, with swollen bellies. The skin is coarse, head large, flat at the top and expanded at the side, the nose sunken and flattened at the bridge, the lips thick, chin protruding, mouth wide and gaping, the tongue large. The countenance is dull and heavy; there is general muscular weakness and slowness of sensibility. Associated with these are feebleness or want of intellect, and sometimes deafness and dumbness, perhaps squinting and blindness.

Treatment of cretins is more moral than anything else. Careful training may do much for

them, along with good food, cleanliness, exercise, &c. The disease does not appear to be hereditary, and goitrous people who have removed from the tainted district do not beget cretinous children. It also appears that cretins who have removed from the district where goitre prevails and live in a healthy place may beget children free from both goitre and cretinism.

Cretins are liable occasionally to violent outbursts of temper, which, however, proper training and moral control can do much to prevent. As a rule, however, they are quiet and harmless.

An establishment for the care of cretins has been founded at Abendberg, near Interlaken, in Switzerland, by Dr. Guggenbühl.

Disease connected with the Supra-renal Capsules.

Addison's Disease is the only disease connected with the capsules above the kidney that need be noticed here. It receives its name because it was first described by Dr. Thomas Addison, a physician of London.

The chief **symptoms** are gradual on-coming of extreme weakness and a peculiar discoloration of the skin. The person becomes less and less disposed to bodily exertion, and the least effort brings on shortness of breath and palpitation; and, in advanced cases, sudden attacks of faintness are the result of even trifling exertion. Various other symptoms accompany these—loss of appetite, sickness and vomiting, dimness of sight, headache, chilliness, &c. The discoloration of the skin is in the form of a bronzing, beginning as a darkening of the skin, first in the face, neck, and hands, and then in the lower parts of the body, the hue gradually deepening till the dark colour is attained. The bronzing is due to the deposition of colouring matter in the cuticle or scarf skin. These symptoms are associated with alteration of structure of the supra-renal capsules. Since Dr. Addison published his discoveries, however, cases of disease of the capsules have been met with in which there was no discoloration of the skin.

Death usually results from weakness, and occurs commonly within a year, though the disease may continue for several years before it proves fatal.

Treatment is vain. All that can be done is to maintain the patient's strength, as much as possible, by wholesome food, tonics, and perhaps stimulants. The person should also be kept at rest, since fatal prostration may result from slight exertion.

SECTION VIII.—THE BLOOD AND THE CIRCULATORY (HEART AND BLOOD-VESSELS) SYSTEM.

A.—ITS ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Blood:

Its Structure and Microscopical Appearance—Plasma—Red and White Corpuscles;
Its Coagulation—Fibrinogen and Fibrinoplastin;
Its Chemical Composition—Hæmoglobin—Gases;
Its Functions.

The Apparatus of the Circulation:

The Heart—Its Shape and Size—The Pericardium—Its Chambers and Valves—Blood-vessels connected with it—Its Action and Nervous Control;
The Blood-vessels—Structure of Capillaries, Arteries, and Veins;
The Distribution of the Blood-vessels.

The Circulation of the Blood:

The Circulation in the Body generally and in the Lungs—The Portal Circulation;
The Circulation in the Arteries—The Pulse;
The Circulation in the Capillaries—Vascular and non-vascular tissues;
The Circulation in the Veins—Summary of the forces that carry on the circulation;
The Rapidity of the Circulation;
Nervous Control of the Circulation—Vasomotor Nerves—the Production of Blushing and Pallor.

THE BLOOD.

The Structure of the Blood.—This work is, of course, designed more for consultation than for systematic reading. Nevertheless it has been considered advisable to take up one part of the body after another in a regular order, so that, if any one chooses to read the

sections on Anatomy and Physiology in the order in which they are given, a general and connected account of the whole body in its structure and workings will be obtained. It is of value for the understanding of the subject of this section to consider, for a moment, what stage has been reached in the regular study of the body. In Section VI. we discussed the process of digestion, and perceived that the whole end and aim of that process was to prepare material fit to enter the blood and maintain its quality and quantity. The consideration of the lymphatics and blood glands, in Section VII., showed that the blood received supplies from lymphatic vessels of lymph prepared by lymphatic glands, and had also additions made to it by the blood glands, notably the spleen. We thus perceive that the blood, which is being continually drained by the demands made on it by the whole body for its nourishing material, has two main sources of supply, namely, first and chiefly, the food, and secondly, the lymphatics and blood glands. We shall see in the succeeding section that this does not exhaust the sources whence the blood draws supplies, and that the lungs are the channel by which a substance is conveyed to the blood, not second in importance to what is received by the alimentary canal, the substance oxygen gas, namely.

Such being the sources of the blood, our next question is as to its nature.

The microscopic appearance of blood.—The microscope reveals much as to the nature of the blood. Blood is prepared for examination by the microscope in a very simple way. The twisted corner of a handkerchief is wound tightly round the end joint of a finger. That obstructs the flow of blood, and the point of the finger becomes purple and congested. A smart dab with a clean needle draws a drop of blood at once. A small quantity is got on the centre of a slide, such as is used for microscopic purposes, by making the slide touch the drop, and it is immediately covered with a very thin circle of glass (a cover glass). The slide is then put on the stage of a microscope and examined. Under a moderately high magnifying power the appearance represented in Fig. 114 is seen. The blood is evidently not altogether fluid. It contains small bodies in great numbers, which are floating in a liquid. Contrary to what would be expected, the liquid is of a light straw colour, indeed almost colourless. The small bodies, however, are coloured. They appear red when seen in layers, but singly they are yellow. The fluid is called **plasma, or liquor sanguinis** (liquid of the blood); the small bodies are the **red corpuscles** (small body, Latin *corpus*, a body) or cells of the blood. If the preparation be quickly examined, or if the cover glass be gently disturbed with a needle, the corpuscles will be seen separate from one another, but they quickly run together to form rows or rouleaux, like piles of coin, as represented in the figure. This is owing to their shape. If one be carefully

Fig. 114.—A Drop of Blood, seen under a Microscope magnifying by 350 diameters.

examined as it lies on its edge, it presents the appearance shown at *a* in Fig. 114, thinner at the middle than at either end. If one be seen lying on its face its appearance is as represented by *b* of the same figure. It is circular, and the centre is dark, while the edge is clear. If the focus of the microscope be altered, the centre becomes clear and the edge dark. In other words the two surfaces of the corpuscle are not flat, they are hollowed towards the centre, so that the corpuscle is thinner at the centre than at the margins. The body is thus hollowed on each surface, is, in a word, a biconcave disc. On a casual glance the red corpuscles are the only bodies seen in the fluid, but, on looking carefully, other bodies slightly larger and few in number are perceived. They are seen here and there in the spaces formed by the rows of red cells. They keep separate from one another, are white, and contain little dark granules in their interior. They are the **white** or **colourless corpuscles** of the blood, and are also termed **leucocytes** (Greek *leukos*, white, and *kútos*, a cell). They are represented in Fig. 114, *c*. There are usually not more than three or four seen in the field. There is in healthy

human blood, on an average, one white blood corpuscle for every 600 to 1200 red ones. They are irregularly globular in shape.

Much can be learned about these blood cells by simple means. On the addition of water to the drop of blood, the red corpuscles swell up, lose their biconcave shape, and become round. They also become paler, while the fluid in which they float becomes yellowish. The meaning of this change is that the water has entered into the corpuscle, swelling it up, and has dissolved some of its colouring matter, which passes out and stains the plasma. The addition of a strong solution of sugar or salt causes them to shrink and become shrivelled looking, because the fluid parts of the cell have passed out to dilute the plasma, rendered more dense by the addition of the salt solution. The action of acetic acid causes the red blood corpuscle to disappear. It becomes paler and paler, and finally becomes invisible, or at least but the faintest shadowy indication of it is left, if the action of the acetic acid is not pushed. No trace of it may be left. On white blood corpuscles the action is similar, the cell becomes more and more transparent, till the bulk of the granular protoplasm of which it is composed disappears. Something else is, however, brought into view, namely, small bodies—*nuclei*—contained in the cell, but not easily seen, because obscured by the protoplasm, till the clearing up of the cell reveals them. A small white blood corpuscle may contain only one nucleus, the larger ones contain several. Thus, besides the differences already noticed, the red and white corpuscles of human blood differ in this, that the latter are nucleated while the former contain no nucleus.

Almost all vertebrate animals (animals having a backbone) have the kinds of blood cells described, but they are not all of the same appearance as in human blood. In mammals (animals that suckle their young) the red cells are disc-shaped and without a nucleus, except in the camel, where they are oval though without a nucleus. In all other vertebrate animals they are oval and have a nucleus. In man and in all mammals, with the exception of the camel tribe, the red corpuscles are biconcave as already described; but in birds, reptiles, and fishes they are biconvex, thicker in the middle than at the edges. They differ in size also in various animals.

When carefully measured, human red blood corpuscles are found to be about the $\frac{1}{3200}$ of an inch across. [The white corpuscles are larger, being about the $\frac{1}{2500}$ of an inch in diameter.] In the elephant they are $\frac{1}{2745}$ of an inch; in the musk-deer they are very small—$\frac{1}{12325}$. In the proteus, a remarkable amphibian (an amphibian is an animal that has gills like a fish when young, but can breathe air directly when full grown)—in the proteus there are the largest red corpuscles found in any vertebrate animal—$\frac{1}{400}$ of an inch.

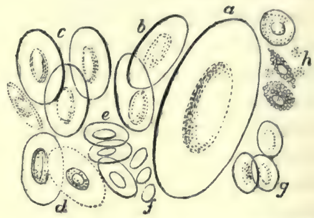


Fig. 115.—Blood corpuscles of various animals magnified in the same scale.

a, From proteus (an amphibian); *b*, salamander (amphibian); *c*, frog; *d*, frog's corpuscle after addition of weak acetic acid, showing nucleus; *e*, bird; *f*, camel, oval, but not nucleated; *g*, fish; *h*, crab or other invertebrate animal.

In Fig. 115 are shown corpuscles of various animals magnified by the same amount.

A remarkable thing about the colourless blood corpuscles is their power of altering their shape. The red corpuscle can have its shape altered, but only by pressure from without. The pressure of one on the other changes the shape, and on removal of the pressure the old shape returns. If a red corpuscle is passing through a narrow channel it lengthens and becomes narrow till it has passed through, when its shape is restored. But the white corpuscle is active in its change. It is constantly changing, but so slowly as to be with difficulty noticed in an ordinary preparation of a drop of blood. The change of shape is effected by what is called *amœboid* movements, because the movements are similar to those of the *amœba*, a minute living thing found in stagnant fresh-water pools. The corpuscle can push out and draw in portions of its body, which is now globular and now elongated. By such changes of form the cell may wander from place to place. Recent observations have shown that the white corpuscles may wander out of the blood-vessels in the living body, pushing their way through the living walls and insinuating themselves amongst the tissues outside the vessels. The cells have been called, in consequence, *wander cells*. Moreover, the cells that form the matter of an abscess are not distinguishable from the white cells of the blood, and it is not certain whether they are not cells which have passed out of the blood-vessels in the process of inflammation. (See p. 247.) Again, the white cells found in lymph after it has passed through

a lymphatic gland, found also in such numbers in lymphatic glands and in the spleen, are identical with those of the blood. It is supposed that they take their origin in the spleen and lymphatic glands, and that the red corpuscles are afterwards developed from them. The number of white cells increases in the blood after meals and quickly diminishes again. Thus a German observer estimated the proportion of white cells to red before breakfast as 1 to 1800, an hour after breakfast as 1 to 700, and some hours later as 1 to 1500.

The **quantity of blood** in the body has been estimated in various ways, though, of course, the quantity cannot be stated with absolute accuracy. It is supposed in an adult man to be about one-thirteenth of the total weight of the body, that is about twelve pounds by weight in a person of eleven stones. When the multitude of corpuscles in a single drop of blood is considered, it will be evident that the total number of corpuscles in the blood of the body is scarcely countable, and certainly quite inconceivable. They have been counted, however, and the estimate is that in the $\frac{1}{625}$ of a cubic inch of blood there are a little over five millions of corpuscles. It has also been estimated that if all the red blood corpuscles in the blood of an adult man could be laid down side by side, they would cover an area of 3000 square yards.

In the disease called *anæmia* the number of red corpuscles is greatly diminished. *Plethora* is the term applied to the opposite condition, in which the number is greatly in excess of the usual number.

Coagulation of the Blood.—If blood be drawn from an animal into a vessel surrounded by a freezing-mixture it remains liquid. The corpuscles, being heavier than the fluid in which they float, fall to the bottom, and thus the blood is separated into the corpuscles at the bottom of the vessel, and the plasma or liquor sanguinis above. If the blood were kept in the fluid state for a sufficient time the difference in the layers of plasma and corpuscles would be marked by the great difference in colour, the plasma being almost colourless, and the layer of corpuscles of a deep red. If, then, the cold were withdrawn the blood would speedily cease to be fluid, and would become a coagulated or clotted mass, the solidified plasma having the appearance of a clear jelly with a yellowish tinge. The cause of the clotting is easily seen if one takes a drop of blood on a slide, and waits for a minute or two before putting on a cover glass and examining it. In two or three minutes the drop of blood on the slide forms a clot. On covering it with a covering glass, and examining with the microscope, fine glassy fibres are seen forming an irregular net-work, in the meshes of which lie the corpuscles. It is the formation of these fibres that has caused the setting of the drop of blood. The substance thus formed from blood, after it is withdrawn from the vessels, is called **fibrin**. It consists of white, structureless filaments or threads. It does not seem to exist in the blood as fibrin, as we shall see, but is formed after the blood is drawn, or after contact of the blood with foreign bodies. Fibrin is formed very quickly in blood removed from the blood-vessels, but its formation may be delayed by cold, as we have already seen, or by the addition to the blood of certain salts, common salt, for example. Fibrin may be separated from blood, before coagulation takes place, by whipping the blood with twigs. The fibrin forms on the twigs, from which it can be washed off, when it appears as a white stringy substance. The blood left behind will no longer coagulate, because the fibrin has been removed.

Suppose now that blood be drawn into a tall glass vessel, no precautions as to the maintenance of a low temperature being taken, in from five to ten minutes coagulation takes place throughout, and a sort of firm red jelly is formed. The corpuscles, not having time to sink to the bottom, are entangled in the meshes of the fibrin, and the whole mass is red in colour. The clot takes the shape of the vessel in which it is contained. If a little delay has taken place in coagulation the corpuscles have sunk to some extent, and the clot will have a deeper colour towards the deeper parts, the bottom layer being deepest of all. The white blood corpuscles are, however, lighter than the red. They do not sink so fast, and are, therefore, entangled towards the surface of the clot, giving it a whitish or creamy look on the top. This used to be called the **buffy coat**. Where the coagulation has been very quick, the separation has no time to be effected, and the buffy coat is absent. If the clot be left alone in the glass vessel, by and by other changes take place. The fibrin, whose formation has caused the coagulation, begins to shrink. As the clot is attached to the sides of the vessel the shrinking is more pronounced towards the centre, and thus the surface of the clot gets hollowed or **cupped**, as it is called. The shrinking of the clot squeezes out a clear yellowish fluid, which soon separates the clot from the sides of the vessel, and thus we have the clot floating in a fluid of a straw-yellow

colour. This straw-yellow fluid is **serum**. Now let us distinguish between serum and plasma. In blood as drawn from an animal we have corpuscles, and plasma or liquor sanguinis. By coagulation the plasma is separated into fibrin and a fluid—the serum. Thus blood, less its corpuscles, is plasma or liquor sanguinis; and plasma, less its fibrin, is serum. This difference may be represented in the following way:—

Circulating Blood consists of—		Coagulated Blood consists of—
Liquor Sanguinis or Plasma	= { Serum	Serum
	Fibrin →	Clot
Corpuscles (red and white) →		Clot

It was formerly supposed that the fluid part of the blood held fibrin in solution, and that, when coagulation took place, the fibrin was precipitated or became solid, as in well-known chemical reactions, or that it became solid in consequence of something escaping from the blood, which held it in solution. The view now held is that fibrin does not exist as such in the blood, but is formed, at the time of coagulation, by the union of two substances, called **fibrinogen** and **fibrinoplastic substance**, previously in solution in that fluid. Why these substances do not unite in the blood in the vessels of a living animal has not yet been satisfactorily determined. In certain diseased conditions, however, they do unite. Thus foreign bodies introduced into the current of the circulation—a thread drawn through a blood-vessel and left there, for example—soon become covered with a layer of fibrin. It is well known, also, that a deposit of fibrin may readily occur on a part of the surface of a blood-vessel, or of the valves of the heart, that has been roughened by inflammation. When a clot is thus formed, either in the heart or vessels, it is called a **thrombus**. The risk of such an occurrence is great, and it is specially so when the deposit is on the edges of one of the valves of the heart, for a part of the clot may be detached and whirled away in the current of blood till a vessel is reached too small to give it passage. The clot blocks the vessel, and thus the area which it supplied with blood is either permanently or temporarily deprived of its supply. In such a case the clot is called an **embolus**, and the occurrence **embolism**.

It is by the formation of a clot that bleeding from a vessel that has been opened is stopped naturally. The clot closes the opening, and gradually fibrous tissue becomes formed at that part of the vessel, which thus becomes permanently closed. When a wounded artery is tied the same thing happens. A clot forms at the tied part, and finally fibrous tissue takes its place and the vessel is completely sealed up.

The Chemical Constitution of the Blood.—Human blood has an average specific gravity of 1055; it has an alkaline reaction, which in shed blood quickly diminishes up to the moment of clotting. We have seen that circulating blood consists of corpuscles (red and white) floating in plasma. Of the total weight of blood more than one third, and less than one half, is made up of the corpuscles, and the rest of the weight is made up of plasma. The plasma contains fibrin and serum, the fibrin forming about ·2 per cent, a remarkably small quantity considering the part it plays in coagulation.

The **red corpuscles** consist of 57 parts of water and 43 parts of solid matters in 100 parts of the wet corpuscles. The solid matter is mainly a substance called **hæmoglobin**, forming 90 per cent of the solids of the corpuscles, the remainder being proteid substances, traces of other organic substances (cholesterin and lecithin), and inorganic salts—the salts of potassium and phosphates. Hæmoglobin consists of an albuminous body, **globulin**, and a colouring matter, **hæmatin**, and it is capable of crystallizing in various shapes. It is remarkable for containing 4 parts of iron in 1000. Hæmoglobin forms a combination with oxygen gas called **oxy-hæmoglobin**, which is of a bright scarlet colour. But the oxygen may be removed from the hæmoglobin, which then becomes of a darker and more purple hue; or, if carbonic acid gas be substituted for the oxygen, a dark colour is produced. This is the essence of the explanation offered for the difference between the scarlet blood found flowing in arteries, and the more purplish blood of the veins. This is explained at greater length in Section IX. If hæmoglobin, dark in hue because it has been deprived of oxygen, be exposed to an atmosphere containing that gas, it seizes upon it greedily, and speedily becomes of a bright hue. This is the reason why blood which may have been dark when shed, becomes of a bright scarlet colour, at least on the surface, if exposed to the air. It seizes on the oxygen of the air. Thus the red blood corpuscles consist mainly of a substance greedy for oxygen, and thus these bodies become the oxygen carriers of the body, seizing upon the oxygen which they get in the air in the lungs, and hurrying with it to the remotest parts of the body. (See Section IX.)

Hæmoglobin, it may be added, is also called **hæmatoglobin** or **hæmatocrystallin.**

The **serum** of blood, that is, the plasma deprived of its fibrin, consists of water 90 per cent, albuminous or proteid substances 8 to 9 per cent, and 1 to 2 per cent of fats and saline matters, and substances capable of being dissolved out by alcohol or ether, and hence called extractives, such as urea, kreatin, sugar, lactic acid, &c. The saline matters are chiefly salts of sodium. Thus the serum differs from the corpuscles in which the potash salts are found.

The blood also contains *gases*, which may be separated from it by allowing the blood to flow into a vacuum at a temperature higher than blood heat (98°·4 Fahr.). At the ordinary pressure of the atmosphere, 30 inches of mercury, and a temperature of 32° Fahr., the quantity of gas separated from 100 volumes of blood is about 60 volumes. It consists of oxygen, carbonic acid, and nitrogen, in different proportions according to whether the blood was arterial or venous. Thus the 60 volumes are distributed as follows:—

	Of Oxygen	Of Carbonic Acid	Of Nitrogen
In arterial blood,...	20 volumes	39 volumes	1 to 2 volumes.
In venous blood,...	8 to 12 ,,	46 ,,	1 to 2 ,,

The significance of these figures will be commented on at greater length in the section in which breathing and its purposes are discussed (Section IX.); but it is well to note now that arterial blood contains more oxygen and less carbonic acid gas than venous blood. With that fact we at once associate the bright scarlet hue of arterial blood, and the purplish colour of venous blood, remembering the love of the hæmoglobin of the red blood corpuscles for oxygen, and the bright colour resulting from its satisfaction, and the dark colour resulting from deprivation.

The Functions of the Blood are to carry nourishment to every tissue and organ of the body. It may be compared to a stream flowing through a tract of country, and giving off branches in all directions, so that it waters every quarter of the district. We know that that tract of country is likely to be extremely fertile, and we know what a change would come over it if the river were dried up; or, if one branch only were suddenly cut off, we know what a contrast the part formerly supplied by that branch would present to the rest, still watered as before. Now for the tract of country substitute the human body, and for the stream, with its many branches to every part of the country, substitute the blood carried in channels (the blood-vessels) to every portion of the body, and we have a very striking similarity. For the blood flowing through a part of the body as surely bathes the tissues beside which it flows, as does a river water the fields along its banks. Thus the liver cells (p. 141) are situated in groups on the blood channels, which exist in such abundance in the liver. As the stream of blood flows past, they select from it what they need for their work, just as different trees and plants along the bank of a stream will suck up what nourishment they need. The liver cells select from the blood the substances out of which they may manufacture the bile salts, the bile colouring matters, &c. It is the same blood that flows through the brain, and here it comes in contact with brain cells, whose function, connected with thinking, feeling, willing, &c., is very different from that of the liver cells. Nevertheless from the same blood they find nourishment for their life and the source of their activities. They too select from it the substances they need, and convert them into that which it is their business to produce, and which is something very different from bile salts and colouring matters. It is the same blood that flows through a muscle and bathes the muscular fibres. They also find in it the elements that are necessary for restoring exhausted muscle fibres and building up new ones. It is the same blood that flows through the tissues of the eye and maintains in health and power this most wonderful of optical instruments. In short, just as in one garden you may have the lily and the rose near neighbours to strawberry beds and apple-trees, growing from the same earth and having the same rain and sunshine from heaven, yet each one selecting from the common nourishment the elements it needs, and converting them into flower and fruit very different from one another, so the blood in the human body contains nourishment for the liver cell and brain cell, muscular fibre and sentient organ, which each selects as its needs dictate.

While this is the main function of the blood, it serves that other purpose of carrying away, in its current, from the tissues substances, produced by their work, whose removal is necessary for the continuance of the healthy life of the part.

It is, then, quite clear how conditions of the blood speedily affect the whole body. Suppose the blood to be insufficient in quantity. Each

tissue and organ gets a supply, but not enough. Its vigour is, therefore, diminished and its efficiency impaired. If the blood be equally distributed, all parts of the body may suffer equally and general symptoms of ill-health, not symptoms pointing out definitely one suffering part, are the result. In some cases one organ may suffer more than another, may get less than its own share of the diminished supply, and alongside of the general symptoms which point out the general condition, are others indicating some organ on which the privation is specially hard. The blood may, however, be sufficient in quantity but bad in quality. Some particular element may be wanting. For example, scurvy is held to be due to absence from the food of some element, perhaps potash salts, perhaps citric acid, which fresh vegetables supply. Some substance may be present that ought not. For example, the liver may have failed to separate bile, and substances are left in the blood, which, being carried through the body, act directly or indirectly as a poison. Some material may also gain entrance by the food, or air, or in other ways, which vitiates the quality of the blood and impairs its value as a nourishing fluid. How dependent, therefore, the whole body is on the quantity and quality of the blood is evident, and will become more clear when the results of its impaired efficiency are studied in the second part of this section.

THE APPARATUS OF THE CIRCULATION.

The blood being the source of nourishment of all the tissues of the body, its need of constant renewal is apparent, for, otherwise, all nourishing material would speedily be abstracted from it. Moreover tissues not only remove from the blood what they require, but they pour into it the waste products of their activity. If the blood were stagnant in the tissues it would thus not only be deprived of all nourishment, but would be loaded with waste and poisonous material. Therefore, as fresh blood must come constantly streaming to an organ or tissue, so must it as constantly flow away again, carrying impurities with it. The main idea of the circulation is thus easy to understand. There must be a central pump, so to speak, from which large pipes, to continue the illustration, pass off, leading to smaller and smaller pipes distributed throughout the whole body. The blood must be pumped into the large pipes and forced along till it reaches the smallest branches, so that it may have access to the remotest parts. There must also be a second system of pipes, by means of which the blood, after nourishing the tissues and being laden with their waste products, is brought back again to the central pump to be again distributed. Somewhere in this circuit there must be means for purifying the blood from the waste products it has received. Now this central pump is the **heart**, and the pipes leading from it and passing into smaller and smaller branches are the **arteries**, the fine vessels into which they ultimately pass being called the **capillaries**, while the pipes along which the blood is brought back to the heart are the **veins**. Of course there can be no break in the continuity between arteries and veins. The arteries, beginning large at the heart, become smaller and more numerous till they end in the fine, hair-like capillaries; and then the reverse process must go on, the blood passing, on its return journey, from smaller to larger vessels, till the large veins are reached which open into the heart. So that the arteries *end* in the tissues in fine, hair-like vessels—capillaries, and the veins *begin* in the tissues in fine, hair-like vessels—capillaries, and they must be mutually continuous, so that the capillaries of the arteries pass insensibly into capillaries of veins. Heart, arteries, capillaries, and veins form the apparatus of the circulation, and we must understand the apparatus before we proceed to examine the process of the circulation itself.

The Heart is a hollow organ made of muscle, whose fibres resemble, in some respects, those of voluntary muscle, described on p. 68, but are beyond the control of the will, and yet are not identical with ordinary involuntary fibres described on p. 70. It is situated in the chest, between the right and left lungs, which partly cover it. Fig. 116 shows its position.

In **shape** the heart resembles a cone, the base of which is directed upwards. It lies, however, obliquely in the chest, so that the base is not only directed upwards, but also backwards and to the right side, while the point of the cone is downwards, forwards, and to the left side. The heart lies more to the left than to the right, but, as may be seen from the figure, it yet extends slightly beyond the middle line to the right. When the lungs are fully expanded only a small part of the front of the heart is exposed. One may easily map out on the chest of a healthy man the position occupied by the heart. Let a straight line be drawn, in ink, across the

chest on a level with the upper border of the cartilage of the third rib (see Fig. 17, p. 21), let a second line be drawn across at the level of the junction of the breast-bone and xiphoid car-

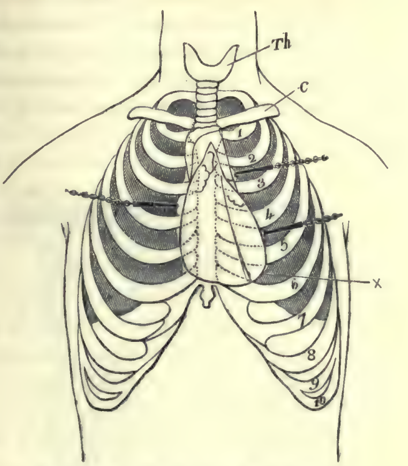


Fig. 116.—The position of the Heart and Lungs.

The lungs are represented shaded and drawn aside by hooks to show the extent of the heart, which is mapped out by continuous lines. *c* shows the position of the collar-bone, and 1, 2, 3, &c., indicate the ribs. The outline of the breast-bone and ribs in dotted lines marks the parts that would require to be removed to expose the heart fully in the body. X points to the apex of the heart, occupying a position between the fifth and sixth ribs. *Th.* is the thyroid gland referred to on p. 205.

tilage (*q* of Fig. 17). These lines indicate the extreme limits which the heart reaches upwards and downwards in health. The extent to which the heart reaches on each side is marked by drawing one upright line at a distance of 1½ inches to the right of the middle of the breast-bone, and a second upright line about 3½ inches to the left of the middle of the breast-bone. The position of the apex is obtained by marking the spot where the heart is felt beating against the wall of the chest (x in Fig. 116), which is usually about 1 inch below, and a little to the right of, the left nipple in the space between the fifth and sixth ribs. With the aid of this mark, and within the lines, the outline of the heart may be drawn, and thus a good idea obtained of its position.

The average **size** of the heart is 4¾ inches long, 3½ inches broad, and 2½ inches thick. It is usually smaller in women than in men. It is roughly measured in individuals by the size of the closed fist.

The **coats** of the heart. The organ is suspended in the chest by the great vessels connected with it at the base, to be considered later; but it does not hang free. It is surrounded by a membranous bag called the **pericardium.** The bag is really a double one, consisting of two layers, one within the other, the inner one being closely adherent to the heart, and being separated from the outer one by a slight space, in which there is usually a small quantity of serous fluid—the **pericardial fluid.** The pericardium passes over the roots of the great vessels at the base of the heart, and it is here that the inner layer becomes continuous with the outer layer. A good idea of the pericardium will be obtained if one takes two thin paper bags, of which one is slightly smaller than the other, so that one may be contained within the other, both being fully distended. Now slightly fold back the edge of the mouth of the inner bag and gum it all round to the edge of the mouth of the outer one. There is now made a double bag with an inner and an outer layer, and a small space between them, completely shut off from the outside. Suppose the closed fist to be just large enough to fill the inner bag, it will represent the heart, to which the inner layer of the pericardium is adherent. The wrist will represent the great vessels passing off from the heart, around which the neck of the double

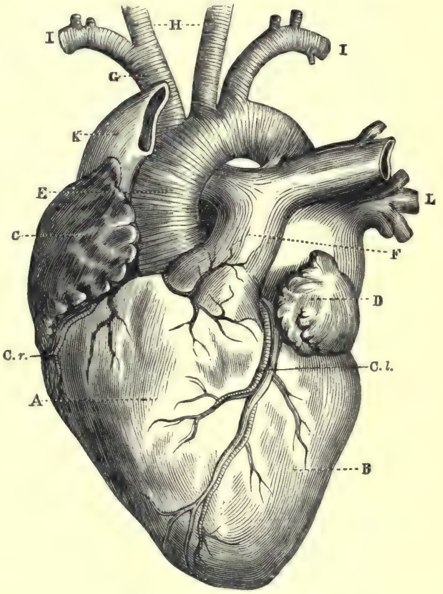


Fig. 117.—The Heart.

A and B, Right and Left Ventricles. C and D, Right and Left Auricles. E, Aorta. F, Pulmonary Artery. G, Innominate Artery, branch of Aorta. H, Right and Left Carotid Branches (to head and neck). I, I, Subclavian Branches (to upper limbs). K, Superior Vena Cava. L, Pulmonary Veins. C. *r.* Right Coronary Vessels. C. *l.* Left Coronary Vessels. Arteries are marked by cross shading in the figure; Veins are shaded lengthways.

bag extends. Part of the pericardium towards the apex is adherent, on the outside, to the diaphragm below—the muscular partition which

separates the chest from the belly. The pericardium forms thus an outer coat or covering for the heart. Within it is the proper structure of the heart, the muscular structure, supplied, like all other muscles, with blood-vessels, nerves, lymphatics, &c. The muscular fibres are disposed in several layers, which appear to be spirally arranged with reference to one another. The inner lining is called the **endocardium**, and is very delicate.

The **chambers** of the heart. It has been said that the heart is a hollow organ, but the cavity is not single. A complete muscular partition divides it into two, so that there is a right and a left side, between which there is no direct communication except in the child before birth.

That partition or *septum* is indicated on the outside of the heart by a groove passing from the base to the apex, along which large blood-vessels run (Fig. 117). This partition, as the groove indicates, keeps to the right side of the apex, so that the whole of the apex is, by this division, on the left side. The two cavities thus formed are each divided by a partition into an upper and a lower chamber. The partitions are not permanent, however, for they consist of flap valves, which, when closed, completely separate the upper and lower chambers, but which are capable of opening so that the chambers become continuous, just as folding doors between two rooms, if closed, make them two separate rooms, but if open, make them practically one room. The heart has thus four chambers, two on each side. Fig. 118 shows them very well. It represents a heart cut open lengthways. From L the upright partition is seen passing, in a slightly irregular course, to M, and it is plainly shown how the apex is kept to the left. The cross partition is in the direction from E to G, and the four chambers are marked C, D, A, and B. Now the two upper chambers are called **auricles** (Latin *auricula,* the outer ear), from their supposed external resemblance to the ear (see Figs. 117 and 118, C and D). There are, therefore, the right and left auricles. The lower chambers are called **ventricles** (Latin *venter*, the belly), for they form the chief portion of the muscular substance of the organ, and there is a right and a left ventricle (Figs. 117 and 118, A and B). There is a great difference between the walls of the auricles and those of the ventricles, the former being thin and soft, the latter thick and strong and very muscular; especially is the increased thickness evident in the walls of the left ventricle. This difference is connected with the greater amount of work thrown on the ventricles and especially the left, as will be seen when the action of the heart is considered (p. 224).

The **valves** of the heart are most important structures. They consist of folds of the inner lining—endocardium—strengthened by fibres of connective and elastic tissue. One is situated in the narrow part between the right auricle and ventricle. It is called the **tricuspid valve,** because it consists of three cusps or flaps. In

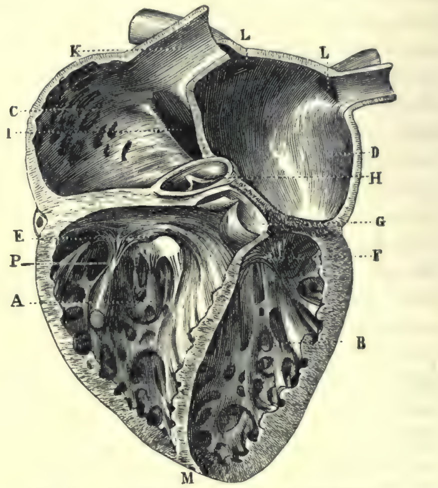


Fig. 118.—The Heart opened to show its Chambers.

A and B, Right and Left Ventricles. C and D, Right and Left Auricles. E, Tricuspid, and F, Mitral Valves. G, Pulmonary Artery. H, Aorta. I, Opening of Inferior Vena Cava. K, Superior Vena Cava. L, L, Orifices of Pulmonary Veins. M, Termination of Septum. P, Papillary Muscle.

Fig. 118 E points to one flap. When the flaps are stretched across they completely close the communication between the upper and lower chamber. On the left side the valve in the narrow part between left auricle and ventricle consists of only two flaps, and is called the **mitral valve** (Fig. 118, F), because of its supposed resemblance to a bishop's mitre. When the valve is closed the flaps meet in the middle line and block the opening between the two chambers. When not stretched across, the flaps of both valves are hanging downwards into the lower chambers, and the passages between the auricles and ventricles are open so that the upper and lower chambers of each side are continuous. The passage on the right side, guarded by the tricuspid valve, is called the **right auriculo-ventricular opening,** that on the left side, guarded by the mitral valve, is called the **left auriculo-ventricular opening.** From the right ventricle a large vessel passes to the lungs—the **pulmonary artery,** and from the left ventricle a large vessel goes off—the **aorta.** The openings of these vessels into the ventricles

are guarded by valves—**semilunar valves.** Each semilunar valve has three flaps, and each flap is half-moon shaped, hence the term semilunar (*semi*, half, and *luna*, the moon). These valves, when shut, cut off the communication, on the right side between the pulmonary artery and the right ventricle, and on the left side between the aorta and the left ventricle. Most cases of heart disease consist of some affection of one or other of these valves; and anything that interferes with their efficient opening or closing may produce most profound changes in every organ of the body. How this is possible will be perceived if the action of the valves is rightly understood.

Let us take the right side of the heart and consider it first. Blood, let us suppose, is pouring into the right auricle from veins that join it, bringing blood from all parts of the body. The tricuspid valve is open, its flaps hanging down into the ventricle. The blood, therefore, having entered the upper chamber flows through the opening into the lower chamber, but the auricle, being smaller than the ventricle, fills sooner. As soon as it is full the muscular walls are stimulated by the pressure of blood on them and contract vigorously. The contraction is accomplished at the expense of the cavity, just as, if a hollow elastic ball be squeezed by the hand, its cavity will be abolished, and the blood which filled the cavity is driven out. In what direction will it go? It may pass in two directions, either backwards into the veins, from which it has come, or downwards into the ventricle. But the mouths of the veins contract along with the auricle, and, besides, the veins are already full of blood, waiting the relaxation of the auricle to enter it. Thus all the blood will be driven down into the ventricle. The auricle having emptied itself begins to relax, and blood, entering from the veins, begins to fill it again. The ventricle contained already a considerable quantity of blood before the emptying of the auricle into it, and the additional quantity, received on the auricular contraction, just fills it. Its muscular walls are stimulated by the force of blood, and thus, as soon as the auricle has discharged its contents into it, the ventricle begins to contract. It contracts with much greater vigour than the upper chamber, because of the increased thickness and power of its walls, and the blood is driven out of it with considerable force. In what direction will it go? It may be forced upwards, back into the auricle, or it may be forced into the pulmonary artery, which passes, as already noted, from the right ventricle to the lungs. Now the tricuspid valve comes into play to determine which of these two directions the blood shall take. The free edges of the flaps are hanging downwards into the ventricle, but the blood is driven by the contraction against them, and forces them up so that the three flaps meet in the middle line and the opening is effectually closed. The action may be roughly illustrated thus: suppose a room filled with people, and the door of the room, which opens only inwards, to be standing half open; suppose now a sudden movement of all the people towards the door, at once the door would be pressed on from behind, and would be speedily shut if the people were moving blindly onwards. The blood, therefore, is prevented passing backwards into the auricle. It is urged, then, into the pulmonary artery, which also is provided with valves, but they open away from the ventricle into the artery. The flaps are, consequently, pressed close against the wall of the artery and the passage is quite free. Suppose the room, already thought of, to have a second door, opening outwards into a passage; the stream of people pressing against it would drive it widely open so that the people might pass out. The ventricle remains contracted for a measurable period of time and then relaxes. The tricuspid valve, no longer pressed close, opens, partly forced to do so by the weight of blood now pouring into the chamber above it, and blood is again permitted to flow into the ventricle from the auricle. Now what is the purpose of the valves at the entrance to the pulmonary artery? While the ventricle remains contracted the blood, driven out of it, is being forced onwards along the artery to the lungs, but because of the ever-increasing smallness of the branches of the artery the blood encounters some resistance to its flow. As soon as the ventricle begins to relax, the pressure, urging on the blood from behind, is no longer exerted, and so the resistance in front tends to cause a back wave which would drive part of the blood back again into the ventricle. The back wave, however, gets behind the pouches of the semilunar valves, forces the three flaps to meet in the middle line, the passage is barred, and the return of any of the blood to the ventricle prevented. To return to our illustration: suppose the room to be emptied of the crowd, who have all passed into the passage, and suppose then the first of the crowd find their way along the passage not easy and try to return. At once the backward pressure of the crowd, catching the edge of the open

door, will force it to close, and communication with the room will be cut off.

A similar series of occurrences is found to take place on the left side of the heart. The left auricle is filled with blood entering by veins. It contracts and forces the blood through the opening of the mitral valve into the left ventricle. A forcible contraction of the ventricle immediately follows; the blood, pressing against the flaps of the mitral valve, brings them together, thus preventing its passing up again into the auricle. It is forced to flow out into the artery, arising from the ventricle—the aorta—whose valves open widely. As soon as the ventricle begins to relax, there is a tendency for the blood in the artery to recoil because of the resistance to its onward movement; and the back wave, getting into the pouches of the aortic semilunar valves, causes them to close, so that the return of blood to the ventricle is prevented.

Thus the valves determine the direction of the flow of blood through the heart. What is likely to arise, should any of the valves fail from any cause to act properly, will be considered in detail under DISEASES OF THE HEART in the second part of this section. One example will, however, not be out of place here. Suppose the mitral valve to be incompetent, as the phrase goes, that is, not to shut completely. Then when the ventricle contracts only part of the blood will pass into the aorta, and some will escape upwards into the auricle. The auricle, which already gets sufficient blood by the veins from the lungs, will always be over-full, and will be unduly stretched to accommodate the additional quantity. The blood will not pass on quickly enough, and the veins, in turn, will become over-full. The over-fulness will speedily pass backwards to the lungs. Its veins will become overcrowded, and a state of congestion will arise which may extend backwards to other organs, liver, stomach, &c.

We have not yet completely exposed, however, the wonderful character of these valvular arrangements. It would readily occur to one that the pressure of blood on the tricuspid and mitral valves, during the contraction of the ventricles, would not only be sufficient to raise the flaps to the horizontal position, but would force them beyond that, and make them open upwards into the auricles, so that the blood would still escape upwards. To prevent this there exists a remarkable arrangement. In the ventricles there are numbers of fleshy pillars projecting from the inner surface. They are called **musculi papillares** (papillary muscles). They have connected with their free points tendinous cords (**chordæ tendineæ**), whose other ends are fastened to the free edges of the valves. Now when the ventricles contract these papillary muscles contract with them and pull on the cords. The cords are of such a length that when the valve is closed they become tight and a doubling upwards of the flap of the valve is thus prevented. In Fig. 118, P points to the tip of one of the muscles, from which cords are seen passing off to a valve. As seen in that figure the inside of the heart is rough and irregular with bands of muscular fibres akin to the musculi papillares. Some of the bands, however, are connected at both ends with the muscular substance of the ventricle, others are like little cones of flesh projecting from the surface, with the apex free but with no tendinous cords. To them the term fleshy columns (**columnæ carneæ**) is applied. It is only to those from whose free extremity tendinous cords pass to the valves that the name papillary muscles is given. The semilunar valves of the pulmonary artery and aorta require no such cords, because they are not simply flaps connected by one edge only, but have a semicircular connection with the artery, just as a pocket may be sewn on to a garment. Each of the three portions of the valve forms thus a little pouch, and when the three pouches are bulged out by the recoil of the blood they meet one another. The greater the backward force of the blood the more do the pouches press back to back against one another, and any doubling back is impossible. In Fig. 118, G points to the entrance to the pulmonary artery opened up, and one pouch and a half are seen, while H indicates the entrance to the aorta cut across at the level of the valve. The shape of the pouches is in both slightly indicated.

The **blood-vessels connected with the heart** are numerous. They have been partly mentioned in the preceding paragraphs. Two large veins open into the right auricle, one at the upper part—the **superior vena cava**, and the other at the lower part—the **inferior vena cava.** The superior cava brings blood from the head, neck, upper limbs, and chest, being formed by the union of two venous trunks, one from the right side of the body and the other from the left. In Fig. 119, E marks the junction of the right and left trunks (K, K) from which the vena cava descends. The inferior cava is not shown in Fig. 119, being behind the parts there shown. It comes from below, and brings the blood from the

lower part of the body. Thus these two large veins bring the blood from all parts of the body and pour it into the right auricle; and, as we have seen, this blood all passes down into the ventricle. From the right ventricle one large vessel arises—the **pulmonary artery** (the lung

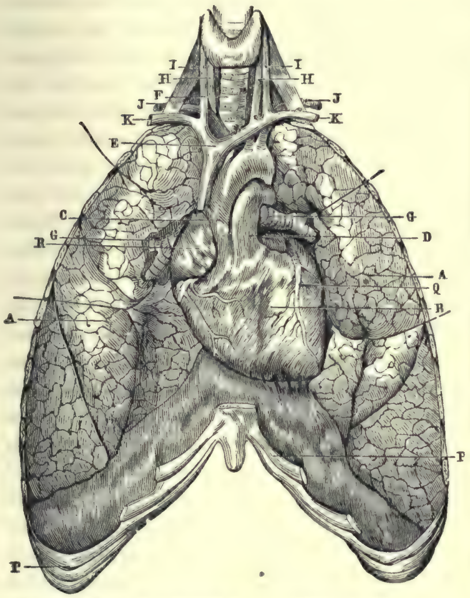


Fig. 119.—The Heart with its Blood-vessels and the Lungs.

A, the lungs pulled aside in front to show the heart, B, and the bronchial tubes, G, G. C, the aorta. D, the pulmonary artery. E, the superior vena cava, formed by the junction of the veins (subclavian) from the right and left sides, K, K. F, the windpipe. I, I, veins from the head and neck (jugular) joining K, K. H, H, arteries (carotid) to head and neck. J, J, arteries (subclavian) passing to right and left sides. P, P, ribs. Q, coronary artery. R, right auricle of heart.

artery; Latin *pulmo*, the lung), which, at a distance of not more than 2 inches from the heart, divides into two branches of nearly equal size, one for the right lung and another for the left. Each branch, having reached the lung for which it is destined, gives off branches, and these branches again give off others, and so the branching goes on till it ends in fine hair-like vessels, capillaries, forming a rich net-work in every part of the lung. Thus the blood, driven out of the ventricle into the pulmonary artery, is by the artery distributed in fine streams throughout the two lungs. Turn now to the left auricle. Four veins open into it, two coming from each lung—**pulmonary veins**, therefore. These veins arise in the lungs from very fine hair-like vessels, which are the continuations of the capillaries of the pulmonary artery. The fine vessels unite to form larger vessels, and so on the process goes till two large veins are formed from each lung, which pass to the left auricle. The pulmonary veins, therefore, carry from the lungs to the left auricle the blood brought to the lungs from the right ventricle by the pulmonary artery, the same blood that previously entered the right auricle from the superior and inferior venæ cavæ. From the left ventricle one large arterial trunk arises—the **aorta**, the largest arterial trunk in the body (c, Fig. 119). It passes upwards in the chest for a short distance towards the root of the neck, where it gives off branches for both right and left arms, and right and left sides of the head. (See Fig. 119.) It then turns backwards and downwards and passes down along the back-bone giving off branches on its way, and ending by dividing into branches for the lower limbs. It is the vessel from which branches arise which *convey* the blood to all parts of the body.

Thus we see that the blood, collected from all parts of the body, enters the right side of the heart by the right auricle, and is poured down into the right ventricle, from which it is forced along the pulmonary artery through the lungs. It is there collected by the pulmonary veins and carried to the left auricle, poured into the left ventricle, and from it forced into the aorta, by the branches of which it is conveyed to every part of the body, only to be again brought back to the right side of the heart. As we shall see in Section IX., a chief object of distributing the blood through the lungs is to have it purified from certain waste substances which it has received in its course through the body, before it is again sent on its journey from the left ventricle. [The various blood-vessels that have been mentioned are shown in Figs. 117 and 119.]

The means by which the muscular substance of the heart is nourished remain to be considered. Close above the semilunar valves of the aorta there arise two arteries—the **coronary arteries**, one of which passes to the right side of the heart and the other to the left. In Fig. 117 c. *r.* points to the right coronary artery, and c. *l.* to the left. Between them these vessels carry sufficient pure blood to nourish the heart. After circulating through the heart substance the blood is collected by **coronary veins**, which pour it into the right auricle. Thus the heart gets its own share of the nourishment which it is its business to drive through the body.

The Action of the Heart.—The heart being the chief instrument in maintaining a steady flow of blood through the body its action must be methodical and regular. It does not contract as a whole. The two auricles contract at the

same instant, and the contraction of the two ventricles immediately follows. While the ventricles are contracting the auricles begin to relax, and after the ventricles have contracted they also relax. There is a period, following the ventricular contraction, when the whole heart is at rest, till the auricles again contract. The order of events is thus—contraction of auricles, contraction of ventricles, pause, contraction of auricles, contraction of ventricles, pause, and so on. The contraction is called **systole**, and the relaxation **diastole**, so that the order of events might be stated as systole of the auricles, immediately followed by systole of the ventricles, and thereafter a period during which the whole heart is in diastole. The occurrences follow one another so regularly as to be called *rhythmic*, and, on that account, the **rhythm of the heart's action** is spoken of. Suppose the heart to be beating 65 to 75 times a minute, which is the average, the time occupied from the instant the auricles began to contract till, after the contraction of the ventricles and the pause, they began to contract again, would be less than a second. Of this time $\frac{1}{8}$th is occupied by the contraction of the auricles, $\frac{3}{8}$ths by the contraction of the ventricles, and the time during which the whole heart is at rest is $\frac{4}{8}$ths of the period. We know, from what has been said in previous paragraphs, that during the contraction of the auricles the blood is being poured down into the lower chambers, that immediately after they have emptied themselves they begin to relax and to be refilled from the veins, that during the ventricular contraction the blood is being forced into the arteries, the pulmonary artery on the right side, and the aorta on the left, and that during the relaxation both auricles and ventricles are refilling. We know also that during the ventricular contraction the tricuspid and mitral valves are closed to prevent the return of blood to the auricles, while the valves of the arteries are open to permit of the blood passing into them, and that during the relaxation the tricuspid and mitral valves are open, while the valves of the arteries are closed to prevent the return of blood to the ventricles.

The **beat** of the heart. These occurrences are attended by various others worthy of note. The first of these is the beat of the heart. If the hand be laid flat on the chest over the region of the left nipple, the heart will be felt beating against the chest wall. This is due to the fact that, by its sudden and vigorous contraction, the point of the heart is jerked forwards against the chest-wall. The impulse should be felt in the space between the fifth and sixth ribs, an inch below and a little to the right of the left nipple. It is important to know this position, for the heart is sometimes displaced by disease, and the beat indicates its new position.

Sounds also accompany the heart's action. If the ear be applied over the heart two sounds will be heard following one another with perfect regularity. They have been imitated by uttering the syllables *lupp*, *dupp*. One is heard immediately after the other, then there is a pause, and then the two sounds again; and so on. They are distinguished by being called the *first sound* and the *second sound*. The second sound is short and sharp as compared with the first. It is not certain what the first sound is due to, but while it is being produced the ventricles are contracting, the tricuspid and mitral valves are closing, the blood is rushing into the arteries, and the heart is driven against the chest. The second sound has been conclusively shown to be caused by the closing of the semilunar valves of the pulmonary artery and aorta, and while it is being produced the ventricles are relaxing, and the blood is entering both upper and lower chambers. These sounds afford indications of the greatest importance in the detection of heart disease. For, if the valves of the heart are diseased, the sounds will be either accompanied or replaced by blowing murmurs, owing to the blood rushing past roughened surfaces, and if one can detect which sound is associated with the murmur, the valve affected may be determined and the exact position of the disease fixed.

The **work** of the heart. Work done by an engine may be measured by the weight it can lift through a certain distance, or the distance through which it can lift a certain weight. Thus if one were to say a load of 100 pounds was lifted 1 foot high, a perfectly accurate idea of the work done would be gained, and it would amount to the same thing if a weight of 1 pound were lifted 100 feet high. Thus work done is measured by "foot-pounds," that is, the number of pounds weight lifted multiplied by the number of feet through which it was lifted gives the work done. The same method can be applied to measure the work done by the heart. With every contraction of the ventricle 6 ounces of blood are forced into the aorta. It has been found that if the blood were thrown out freely, it is sent out of the ventricle with such force that it would rise to a height of 6 feet. Thus with every stroke of the ventricle the work done is equal to raising

6 ounces 6 feet high, or, what is the same thing, 36 ounces 1 foot high. But 36 ounces are $2\frac{1}{4}$ pounds; therefore, the force exerted by the ventricle at each beat is equal to $2\frac{1}{4}$ foot-pounds. Suppose the heart beats 70 times a minute, $2\frac{1}{4}$ multiplied by 70 are equal to a force of $157\frac{1}{2}$ foot-pounds exerted by the left ventricle in one minute. Multiply $157\frac{1}{2}$ by 60, the number of minutes in an hour, and then by 24, the number of hours in a day, and the result is 226,800 foot-pounds of work performed by the left ventricle in a day. If we add to this the work done by the right ventricle, it would equal, by a rough estimate, 300,000 foot-pounds per day, that is, 300,000 pounds lifted 1 foot high; that is, a sufficient force is developed by the heart in one day to raise the body of a man, weighing 150 pounds, 2000 feet in the air. That force seems enormous. It is worth noting the conditions of its development. They are *proper nourishment*, conveyed to the heart's substance by its own system of coronary vessels, and *a regular alternation of work and rest*, for we have seen that during the period of its round the heart works three-fifths of the time and rests two-fifths.

The nervous control of the heart. The regular rhythmic movement of the heart is maintained by nervous influence. If a frog be suddenly killed by a blow on the head, and the chest be immediately opened, the heart will be found still beating. If a long piece of straw, fixed at one end, be laid over the heart, the free end will move up and down, showing and exaggerating the movement. More than this, the frog's heart can be entirely removed from its body, and attached to tubes, filled with nourishing fluid, from which the heart is replenished at intervals. By this means the heart can be kept beating vigorously for a whole day or more, and observations made. It has been ascertained by these and similar means that, at various places in the substance of the heart, there are nervous ganglia, that is, masses of nervous matter. It is from certain of these that there proceed, at regular intervals, discharges of nerve energy, which excite the movement. All of the ganglia, however, do not seem to excite movement; the business of one of them seems to be *to restrain*. If the exciting ganglia had it all their own way, the heart would go on contracting at a speed that would be quickly exhausting, and, if the restraining ganglion had it all its own way, the heart would stand still. The one influence, however, modifies the other, and the result is a moderate and regular activity of the heart.

Now these nervous arrangements are within the substance of the heart itself; but the organ is subject to influences from outside of itself. Two nerves are connected with the heart, the pneumogastric nerve (p. 96) and the sympathetic (p. 98). If the pneumogastric be excited by electrical shocks or in other ways, the heart slows, and, if the excitement be strong enough, stops beating, in a condition of complete relaxation and fully distended; if the sympathetic be stimulated, the heart quickens its movement, beats faster and faster, until, if the stimulus be strong enough, it stops, but this time in a condition of complete and rigid contraction. It would, therefore, appear as if the sympathetic were connected with the exciting ganglia of the heart, and as if the pneumogastric were connected with the restraining ganglion.

Now let us observe how these nervous relations act in ordinary life. A person is the subject of some emotion, and his heart is beating faster than usual; that means that the excitement is communicated from his brain by sympathetic nerves to the heart, which it stimulates to increased activity. When a person receives a blow on the stomach which causes him to faint, the explanation is that the blow has produced a profound impression on certain nerves in the belly, which have conveyed the impression to the brain, and from the brain the impression has, in turn, been carried down to the heart by the pneumogastric nerves, causing the heart to cease beating for an instant. This is of the nature of a reflex action (p. 86). If the effect on the heart be so great as to restrain its movements for any appreciable time, death is the result. It is in a similar way that sudden shocks of any kind, severe pain, &c., cause fainting, the restraining influence exerted on the heart by the stimulation of the pneumogastric momentarily suspending its movements.

The Blood-vessels form the channels along which the blood is conveyed. There are three kinds of blood-vessels, capillaries, arteries, veins, which differ from one another in various particulars.

The **structure of capillaries** will be first described, since they are the most delicate vessels. They are very fine tubes formed by long flattened cells united edge to edge. This is shown by staining with nitrate of silver a fine tissue, such as the inner membrane of the brain, the pia mater (p. 91), which contains capillaries in abundance. On then examining the tissue with the aid of a microscope, delicate vessels are seen traversing it in all directions.

The nitrate of silver stains darkly the cement substance between the cells, and thus the fact of the vessel being made up of cells is revealed. This is shown in Fig. 120, *a*, where the clear

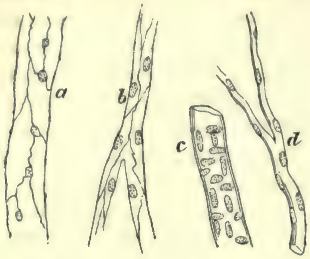


Fig. 120.—The Structure of Capillaries.

areas, mapped out by the irregular dark lines, are the cells. A smaller vessel similarly stained is seen at *b*. At *d* in the figure (where the cells are not mapped out by staining) there is represented a smaller capillary giving off branches so fine that the blood corpuscles would require to travel through them in single file. These are the finest branches, and have no greater diameter than the $\frac{1}{2000}$ to the $\frac{1}{3000}$ of an inch. In *b* and *d* a small body is seen in the centre of each elongated cell. It is a nucleus (p. 15). Now, in vessels larger than capillaries, outside of this layer of cells there are various coats of fibrous, elastic, or muscular tissue, according to the size of the vessel and the strength which it is necessary for it to possess.

The **structure of arteries.**—Arteries have as their innermost coat—the coat next to the channel of the vessel—a delicate membrane, consisting of cells precisely similar to the wall of the capillaries. Outside of this is a coat of fibrous tissue, with an abundance of elastic fibres in it. Outside of this again is what is called the *middle coat*, consisting of elastic tissue and fibres of involuntary muscle disposed circularly round the vessel. These coats are indicated in Fig. 121, which represents an artery dividing into two branches. *a a* point to the inner lining membrane of cells, *b b* to the middle muscular coat, which has been acted on by acetic acid to show the nuclei of the cross muscular fibres; and *c c* point to the outer coat. Fig. 120 *c* represents a small artery or vein in which the nuclei of muscular fibres running both lengthwise and across are shown. The outer coat of an artery consists mainly of fibrous tissue, also with elastic fibres. In the large arteries the elastic tissue predominates, while in the small arteries the muscular coat is more abundant. Thus the feature of the large arteries is their elasticity, while that of the small is their contractility. The importance of this is spoken of on page 231.

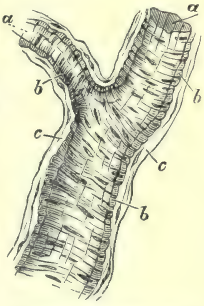


Fig. 121.—Structure of an Artery.

The **structure of veins** is practically the same as that of arteries. They have the same coats, but they are much thinner and more soft. There is also this other difference, that the veins, with some exceptions, have valves, which are directed towards the heart and permit the blood to flow in that direction, while preventing its flow in the opposite direction. In a dead animal an artery may be distinguished from a vein by the stoutness and firmness of its walls, while those of the vein are soft and yielding. Also on cutting through the artery, owing to the thickness of its walls, the tube will be seen to remain open, while the walls of the vein are collapsed and folded on one another. Arteries are in the dead animal generally found empty, the veins only containing blood. It was this observation that led old anatomists to give the name arteries (*arteria*, an air-vessel) to the strong open vessels, because, finding them always apparently empty, they thought that in life they contained the animal spirits.

The **functions** of the various vessels will be noted in discussing the details of the circulation.

The Distribution of the Blood-vessels.

The Arteries of the Head and Neck are among the earliest that spring from the main trunk, arising from the heart—the **aorta**. The **aorta** passes upwards a short way in the chest, as high as the level of the upper border of the second rib, and it then arches backwards towards the back-bone, which, having reached, it turns downwards and passes down through the chest, lying close against the left side of the back-bone. At the arch three branches come off to supply the neck, head, and upper limbs. They are seen in Fig. 117 (p. 219). The first of the three (G in the figure) is called the **innominate artery** (the unnamed artery). It passes towards the right and is very short, splitting into two branches when behind the junction of the collar-bone and breast-bone. One of the branches (I) is the **subclavian artery,** which arches across the lower part of the neck behind

the collar-bone on its way to the right arm, giving off bránches to the head, neck, and chest in its course. In Fig. 122 the number 12 points to a part of it that is least covered by muscles. The other branch (H in Fig. 117) is the **common carotid artery** of the right side. It passes up the side of the neck, running alongside of the windpipe and larynx, to the level of the angle of the jaw. Here it divides into two. An external portion—**the external carotid**—passes up in front of the ear, where it ends in branches to the neck, face, and outer parts of the head. The other branch—**internal carotid**—passes deeply into the neck, and, through an opening in the skull behind the ear, enters the brain, supplying it and the eye with blood. Fig. 122 shows slightly the ramifications of these vessels

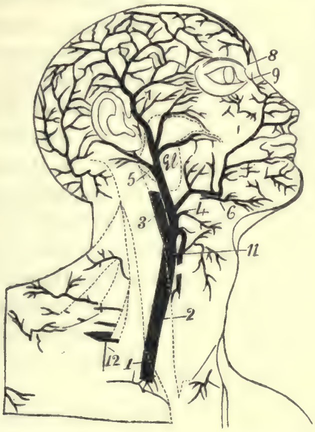


Fig. 122.—Arteries of the Head and Neck.

1 and 2, the common carotid artery, 2 being the part covered by muscle as indicated by dotted lines; 3, the internal, and 4, the external carotid. Some branches of the external carotid are shown, 5 to parts behind the ear, 6 to parts under the chin, 7 to the side of the head, and 9 to the nose. 8 points to a branch of the internal carotid which comes out from within the skull above the eye and is distributed over the forehead. 11 is a branch passing down to the front of the neck. 12 points to part of the subclavian artery. *Gl* shows the position of the salivary gland.

over head and neck. It is to be noted that in the neck the carotid artery lies deeply under muscles so as to be well protected from injury, but that the external carotid comes more near the surface about the angle of the jaw. The arteries of the left side are similarly disposed, but their origin is slightly different. The common carotid artery and the subclavian artery of the left side arise, each separately and not by a common trunk, from the arch of the aorta, as shown in Fig. 117, p. 219.

Arteries of the Upper Limb.—The subclavian artery, mentioned above, after passing under the collar-bone and over the first rib, takes its course through the arm-pit to reach the arm. In the arm-pit it is called the **axillary artery**. When it has entered the arm it is called the **brachial artery.** In its passage through the arm-pit the vessel furnishes branches to the chest and shoulder. Fig. 123 indicates the general course of the vessel in the arm and its distribution. If the arm be held straight out from the side, palm up, the course of the vessel is indicated by a line right through the centre of the arm-pit and over the arm to the middle of the front of the elbow. In its course through the upper arm it is covered by little besides skin and fat; and it gives off branches to the muscles and bone. It becomes deeper at the elbow and there divides into two (Fig. 123), one artery for the radial or thumb side of the forearm—the **radial artery,** and the other for the little finger or ulnar side—the **ulnar artery.** The former passes down to the wrist, where it winds round to the back of the wrist and then reappears in the palm between the thumb and first finger. The ulnar artery runs to the wrist and passes into the palm, as shown in the figure. The ends of both arteries form arches in the palm, a superficial arch formed by the ulnar, and a deep arch formed by the radial; from the arch near the surface branches proceed to each side of the fingers, and from the deep arch deep muscles and the back of the hand are supplied. It is by the radial artery at the wrist that the pulse is felt. The ulnar artery supplies a branch near the bend of the elbow, which proceeds deeply into the forearm and gives offshoots to the back of the forearm.

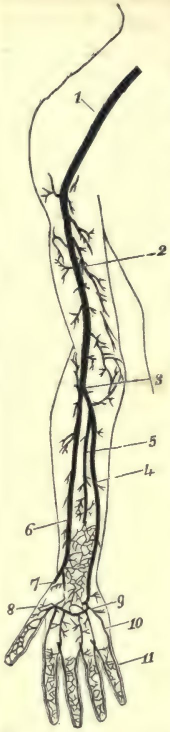


Fig. 123.—Arteries of the Front of the Arm.

1, the axillary artery; 2, the brachial artery, dividing at 3 into 6 the radial, and 4 the ulnar artery, the ulnar giving off a deep branch 5. 7 the radial artery, winding round the back of the wrist to re-appear at 8. Between 8 and 9 the superficial arch in the palm giving off branches, as 10, to end along the side of the finger, 11.

Arteries of the Lower Limb.—It has been mentioned that the aorta passes down through the chest, lying alongside of the back-bone. On its way it gives off branches to the organs

of the chest—the **bronchial arteries** to the air-tubes of the lungs, branches to the gullet, branches—**intercostal**—which run between the ribs, &c. In its descending course the aorta passes through the diaphragm (p. 130) and enters the cavity of the belly. Here a short thick trunk leaves it—the **cœliac axis**—from which arteries arise for the stomach, liver, and spleen. A little further on its way it gives origin to two **mesenteric arteries**, for the supply of the intestine. Similarly other branches pass off from the aorta in the belly for the kidneys —**renal arteries.** Low down on the front of the back-bone the aorta, as such, ceases by splitting into two large vessels—the **common iliac arteries**—one of which passes to the right, the other to the left. Each one of these speedily splits into two branches, of which one, the **internal iliac artery,** goes deeply into the pelvis (p. 22), supplying the muscles and organs there, bladder, &c., and gives off vessels to the buttock, while the other, the **external iliac artery,** issues from the belly about the middle of the groin. This vessel, when it has appeared in the front of the thigh, is called the **femoral artery.** Its general course is indicated in Fig. 124. A line, drawn from the middle of the groin over the front of the thigh to a little above the inner side of the knee-joint, would pretty accurately map out its course. One noteworthy feature of it is that, in the upper third of the thigh, it is covered only by fat and skin, but after that it passes deeply into muscles. It is, therefore, over this upper portion in front of the thigh that pressure is exerted (as shown under ACCIDENTS AND EMERGENCIES) to block the vessel and so prevent further bleeding, otherwise uncontrollable, from any part below. The artery gives off many branches in its course for the supply of the thigh and other parts. Having reached the inner side of the lower part of the thigh, the vessel passes backwards into the ham, or popliteal space, as that part is called by anatomists, where it receives the name of **popliteal artery.** It courses through the middle of this space over the knee-joint, giving off numerous twigs to muscles and to the joint on its way. Below the knee-joint it ends by dividing into two. The course of one of the two, the **posterior tibial artery,** is shown in Fig. 124, as it passes down the inner side of the leg to the ankle, where it ends in branches for the sole of the foot. In Fig. 125 is represented the course of the other branch, called the **anterior tibial artery.** Beginning below the knee on the outer side of the leg it courses down the leg towards the middle of the front of the ankle, buried deeply under muscles till it nears the ankle. Its continuation proceeds over the back of the foot to the space between the great and second toes, through which it passes to join vessels in the sole. Fig. 125 indicates how its branches supply the back of the foot.

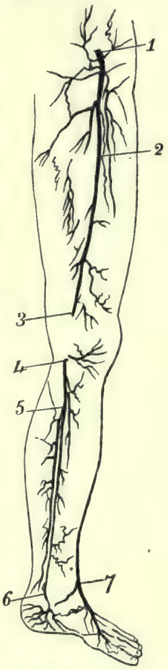


Fig. 124.—The Arteries of the Lower Limb.

1, the femoral artery, passing deeply into the thigh at 2 and winding into the ham at 3; 4, its posterior tibial branch, which passes to the ankle at 6, giving off a large branch at 5; 7, part of the anterior tibial artery shown in Fig. 125.

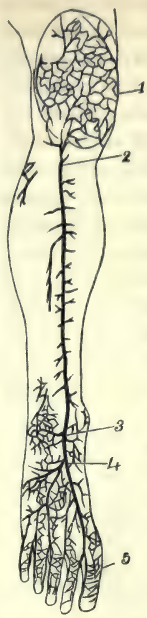


Fig. 125.—Arteries of the Front of the Leg.

1, an indication of the blood supply over the knee-joint; 2, the anterior tibial artery, passing to 3, the ankle, continuing over the back of the foot, 4 and 5, giving off twigs.

From this brief account of the general distribution of the arteries in the body it will be seen how all the arteries arise, directly or indirectly, from one large trunk—the aorta—proceeding from the left ventricle of the heart.

Veins of the Head and Neck.—The general arrangement of the surface veins is indicated in Fig. 126. They are seen converging towards three main vessels, namely, the **external jugular vein** (2 in the fig.), the **internal jugular vein** (3), and the **anterior jugular vein** (4). Of these the **external jugular** begins near the angle of the jaw by the union of a vein from the head and deep parts of the jaw (6) and a vein from the region behind the ear. It passes over the sterno-mastoid muscle (shown in dotted outline) to disappear behind the collar-bone (at 1), where it joins another large vessel, the **subclavian vein.** It is a vessel very near the surface and liable to injury. The internal jugular receives blood from the cavity of the skull and descends in the neck along with the common carotid artery. It is thus placed deeply in the neck

and mostly covered by the sterno-mastoid muscle. It joins the subclavian vein, as shown in Fig.

Fig. 126.—Surface Veins of the Head and Neck.

1, 2, external jugular; 3, internal jugular; 4, 5, anterior jugular; 6, vein formed by junction of veins from head and jaw going on to the external jugular; 7, vein of the face; 8, vein of the forehead.

119. In Fig. 126 it is shown receiving a large branch from the face. The **anterior jugular vein** runs down the neck near to the middle line and joins the external jugular behind the sterno-mastoid muscle. Thus directly or indirectly the veins of the head and neck, which carry the blood from that region back to the heart, all join the subclavian vein (see Fig. 119), which is a continuation of the large trunk carrying the venous blood from the upper limb. On each side the subclavian vein, just at its point of junction with the internal jugular, passes on to a short trunk, called the **innominate vein,** and the two innominate veins, one from each side of the body, join to form the **superior vena cava** (E, Fig. 119), which passes to the right side of the heart. Thus all the blood distributed to the head, neck, and upper limbs is brought back to the heart by one large venous trunk.

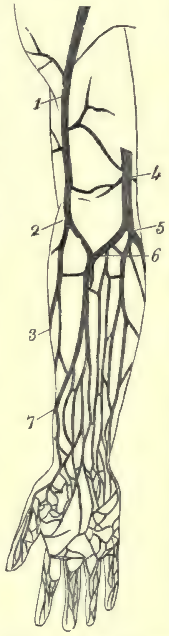


Fig. 127.—Surface Veins of the Hand and Arm.

1, the cephalic vein; 2, 3, radial vein; 4, basilic vein, formed by 5, ulnar vein, and 6, branch of median vein, 7.

Veins of the Upper Limb.—Fig. 127 shows the surface veins of the hand and forearm, uniting to form three main trunks, 3, the **radial vein,** which begins on the back of the hand, 7, the **median vein,** formed by the union of small vessels of the palm of the hand, and 5, the **ulnar vein,** which commences on the inner side of the back of the hand and receives a large branch from the front of the forearm. These vessels form a peculiar arrangement at the elbow, shown in Fig. 127, the median vein, at 6, giving off a branch at one side to the vein, marked 4, the **basilic vein,** and a branch at the other side to the **cephalic vein,** marked 1. It is the branch between 6 and 5 that is usually opened in the operation of bleeding at the arm. The two large veins, cephalic and basilic, pass up the arm. The latter, which in the figure is represented as disappearing a little above the elbow, courses up the inner side of the arm a little more deeply than it is at the elbow, and passes through the arm-pit, being then called the **axillary vein,** over the margin of the first rib and so behind the collar-bone. Here it is called the **subclavian vein,** and its further course has been already noticed. The cephalic vein joins the axillary.

Fig. 128.—Surface Veins of the Inner Side of the Lower Limb.

1, 2, 3, Internal Saphenous Vein.

Besides the veins named there are veins deeply placed in the substance of the upper limb, accompanying the branches of arteries. These all in the end join the axillary vein. Thus this one large vessel carries from the arm all the blood brought to it by arteries.

Veins of the Lower Limb.—Fig. 128 shows the surface veins of the inner side of the leg and foot. One large vein is there seen. Beginning in branches from the inner side of the foot it passes up the inner side of the ankle to the inner side of the knee and thence to the front of the thigh, where at 1 it dips inwards to end in a vein lying alongside of the femoral artery (p. 228). This is the **internal** or **long saphenous vein.** Over the outer ankle and outer side of the leg the **short saphenous vein** runs, but only to the ham, into which it penetrates to join a deep vein.

Deep veins in the lower limb accompany the arteries, the course of some of which has been noted (p. 228). The **femoral vein**, which lies side by side with the femoral artery, passes through the groin into the cavity of the belly to end in the **external iliac vein**, lying alongside the artery of the same name. This vein, carrying all the blood from the lower limb, is joined by the **internal iliac vein**, bringing blood from the buttocks and pelvic organs and cavity. Together they form the **common iliac vein**. The common iliac veins, one from each side of the body, unite near the lower end of the back-bone to form the **inferior vena cava**, which passes upwards in the cavity of the belly, receiving additions from the organs there, from liver, kidneys, &c., pierces the diaphragm, and enters the right side of the heart.

Thus the inferior vena cava brings all the blood from the lower limbs and belly to the right side of the heart, as the superior vena cava performs a like office for the upper part of the body.

The Azygos Veins are two veins, one for each side, which collect the blood that has been distributed in the chest by arteries running outwards between the ribs and in the belly by arteries pursuing a similar course. The vein of the right side (**vena azygos major**) is larger than the one of the left side (**azygos minor**). The latter joins the former in the chest, while the major vein enters the superior vena cava.

Thus all the blood which has been distributed from the left ventricle of the heart throughout the body by the branches of one large arterial trunk—the **aorta**—is returned to the right auricle of the heart by two large veins, the **superior vena cava**, coming from the head, neck, and upper limbs, and the **inferior vena cava**, coming from the belly and lower limbs. On p. 223 it has been described how the blood which enters the right auricle of the heart ultimately reaches the left ventricle, having passed through the lungs and been purified.

THE CIRCULATION OF THE BLOOD.

The Systemic Circulation. The circulation of the blood throughout the whole body is similar to the circulation through the lungs already described (p. 223). The former is called the **systemic** or **great circulation**, the latter the **pulmonary** or **lesser circulation**.

The blood which fills the ventricle is, by its contraction, forced into the aorta, which is already filled with blood, so that to make room for the extra quantity it must distend, and the blood already in it must be forced onwards. As this is happening many times in a minute the blood in the aorta is continually being forced into its branches. Now as we have seen it gives off branches to every part of the body, to head and neck, to the upper limbs, to the chest and the organs in it, to the organs contained within the belly, and to the lower limbs. So that to every region of the body from the crown of the head to the sole of the foot blood is being carried by arteries. As these arteries penetrate into the various regions and organs of the body they give off branches, which are continually becoming smaller, till they become microscopic in size and are found penetrating every part. The smallest arteries end in thin-walled capillaries, which form such a close net-work that a pin cannot be passed into a tissue without opening into some of them. The arteries, even the smallest of them, are simply tubes for conducting the blood to its destination; but the capillaries are something more, for their walls are so thin, that, though continuous, they permit fluid portions of the blood to ooze through to bathe the tissues that surround them. The blood in the capillaries is, therefore, in communication with the tissues surrounding them, and exchanges material with them even as it flows through them. At length the capillaries begin to join together to form larger and larger vessels, and so gradually veins are formed, at first microscopic in size, but gradually the blood passes into larger veins formed by the junction of smaller ones and by the addition of other coats, till the large veins of the particular limb or organ are reached. These join the veins coming from other limbs and organs, until the two large venous trunks are formed, the superior and inferior venæ cavæ, the one coming from the upper and the other from the lower parts of the body, which carry the blood to the right auricle. From the right auricle it passes to the right ventricle, then through the lungs by the pulmonary artery and its branches and back to the heart, but to the left side, by the pulmonary veins, as already described. By passing into the left ventricle the blood has completed its circuit of the body and lungs.

Thus blood which has issued from the left ventricle passes through two sets of capillaries before it returns to the left ventricle—the capillaries of the tissue which it is sent to nourish, and the capillaries of the lung. The blood which

is sent to the stomach, bowels, spleen, and pancreas has, however, an unusually long circuit. After passing through the arteries of these organs, traversing their capillaries, and entering their veins, the blood reaches the **portal vein**, formed, as we have seen (p. 140), by the junction of the veins of the organs mentioned. The blood then passes through the capillaries of the portal vein in the liver and enters the hepatic vein, and so on to the inferior vena cava. Thus blood sent to the stomach and bowels, spleen and pancreas, traverse three sets of capillaries, those of the particular organ, stomach or spleen, &c., those of the portal system in the liver, and those of the lung. This is the longest route a portion of blood may take from the moment it leaves the left ventricle to the moment it returns to it. The shortest possible route is through the substance of the heart itself. A portion of blood entering the aorta, and immediately passing off by the coronary arteries (p. 223), will merely traverse the capillaries in the substance of the heart and return to the right auricle by the coronary vein, completing its circuit by passing through the lungs.

There are various things to notice connected with the flow of blood through arteries, veins, and capillaries, and associated with the differences in the structure of these vessels.

The Circulation in the Arteries.—It has been pointed out that the large arteries are specially elastic. The effect of this is not difficult to understand. Take the aorta as an example. It is filled with blood, but by the contraction of the ventricle an additional quantity is thrown into it. Sufficient room cannot at once be made by the onward flow of that which already occupies the vessel, and so part of the vessel distends sufficiently to accommodate it. As soon as the contraction of the ventricle is over the force distending the artery is diminished, and, by their own elasticity, the walls of the vessel recoil, that is, they return to their natural degree of distension. In doing this the walls press on the blood contained by them, and tend to drive the blood both backwards and forwards. The blood is prevented passing backwards by the closure of the aortic valve, and it must all pass on into the next part of the artery, which in turn distends, being already full, to receive it. The same process is here repeated; the distended wall speedily recoils and passes the blood on to a succeeding part, which, also, first dilates and then recoils on the blood within it. Thus the contraction of the heart is not the only force in driving on the blood. It is aided by the elastic recoil of the arterial walls succeeding it, and the blood is forced onwards in waves.

The **Pulse** is thus explained. If a finger be laid on a part of the body where an artery approaches the surface a throbbing movement will be felt, and the finger, if lightly applied, or better still, a piece of straw laid over the place, will rise and fall in a regular manner, and the beat, thus produced, will be perceptibly in time with the contraction of the heart. This movement is the result of the alternate distention of the vessel by the wave of blood, and the recoil of the walls by their elasticity. It does not occur at the same instant as the contraction of the ventricle, because it takes a little time for the wave to pass from the heart to the place where the pulse is felt, and it is, therefore, a little later at the ankle than at the wrist. Wherever an artery approaches the surface the pulse may be felt. The wrist is the most convenient place, but it is easily found at the temple and the inner side of the ankle. Various influences affecting the characters of the pulse are noted on p. 11.

The **jerky movement** of the blood in an artery is seen if the vessel be cut. The blood does not issue in a regular stream, but in spurts, corresponding to beats of the heart. This enables one to ascertain readily whether a wounded blood-vessel is an artery or a vein, for the flow of blood from the latter is *continuous*. This is of importance, because if an artery be cut we know the blood is flowing *from the heart* to the distant parts of the body. If the loss of blood is to be prevented, the vessel must be closed nearer to the heart than the wound, to prevent new supplies of blood coming on to the wound. This is done by pressing with the fingers or a pad on the heart side of the wound. If, on the contrary, it is a vein that is wounded, we know the blood is flowing in it *towards the heart* from the distant part, and pressure must be exerted on the side of the wound furthest from the heart.

While elasticity is the feature of the large arteries, the **contractility of small arteries** is their characteristic. If the muscular fibres which surround a vessel contract, the channel will be narrowed and less blood will be permitted to flow through it. If the muscular fibres relax, the force of the blood within the vessel—**the blood pressure**—will cause the channel to enlarge by dilating the tube, and more blood will be permitted to flow along. Thus the dia-

meter of the vessel may be regulated by the muscular contraction, and the quantity of blood proceeding to a tissue or organ will be thereby affected. The contraction of the muscular fibres is controlled by the nervous system, and so the nervous system regulates and controls the blood supply to the various regions of the body. How this is effected is explained on p. 233.

Bleeding from small arteries that have been wounded is arrested, to a large extent, by the contraction of the muscular coats of the vessels. Tincture of steel and such substances, when applied to bleeding surfaces, stop the flow of blood because they excite the muscular fibres to contract, and so shut the mouths of the open vessels. It is for the same reason that tannic and gallic acids, &c., are ordered for bleeding from internal surfaces. To diminish and arrest internal bleeding a drug called ergot of rye, or spurred rye, is frequently used with excellent results. Now this drug does not act directly on the bleeding part, but it enters the blood and produces contraction of the muscular coat of the vessels. It arrests bleeding by stimulating the contractility of the smaller arteries.

The Circulation in the Capillaries must be considered next, since the blood flows from arteries into capillaries. The best way to observe the circulation in the capillaries is to fix up a living frog in such a way that the web of its foot is stretched so as to be viewed through a microscope. A fine transparent tissue is seen with clumps of black colouring matter here and there. The tissue is cut up by channels pervading it in all directions, some wide, some extremely narrow. Along these channels blood is streaming. In the wide vessels it is dashing along with apparently great speed, the red corpuscles streaming in crowds down the centre, while the white corpuscles are seen rolling along nearer to the walls of the vessel; in the narrowest vessels there is evidently room for only one corpuscle at a time, and the corpuscles range themselves along, accommodating their shape to the turns and corners so as not to stick in the channel. The noticeable feature is that the current is continuous. When it is remembered that the flow in the arteries is jerky, and that the capillaries are continuous with the arteries, this seems strange. Why is it that the jerking movement of the blood in the arteries is not continued into the capillaries? The explanation is found in the elasticity of the arteries. Were the blood-vessels rigid tubes, then there would be ejected from one end just the quantity of fluid forced in at the other, and in the same intermittent way. The blood encounters resistance in the capillaries, it cannot get along so quickly as in the arteries, the arteries are, therefore, kept constantly distended, and their elastic force is brought into full play. During the pause after each contraction of the heart the elastic walls of the arteries are pressing on the blood they contain, and are following up the force of the heart. It is as if there were two propelling forces, the one following the other so smoothly and regularly that there is no stoppage in the onward movement. If the elastic tube is long enough the result is that, by and by, the wave-like movement of the fluid in it becomes less and less perceptible, till it finally disappears, and the intermittent movement is converted into a continuous flow. It must be observed, however, that it is only where there is sufficient resistance to the progress of the fluid that this can happen, for if there is little resistance the elastic reaction is not brought into play, and the jerky movement continues. The next thing noticeable, connected with the capillaries, is the thin walls of the vessels, so that the oozing of fluid, already referred to, for purposes of nourishing the tissues, is easily understood. Another feature that one remarks is that every minute part of tissue is so surrounded with capillaries that it cannot fail to receive nourishment from all sides.

Generally speaking, every organ and tissue of the body abounds in capillary blood-vessels, even bone being interpenetrated by them. Tissues so traversed by vessels are said to be **vascular**. There are, however, a few tissues which are **non-vascular**, that is, they have no such system of vessels within them. These are epidermis and epithelium, in other words, the surface layer of the skin and mucous membrane; and nail, hair, the substance of the teeth, and cartilage or gristle. Such tissues, however, are closely connected with moist vascular tissues, from which they are able to suck up nourishment.

The Circulation in the Veins is characterized by a continuous flow, the wave-like movement having been completely lost in the capillaries. Besides the force from behind—the force that is transmitted through the capillaries from the arteries—other agents enter to impel the blood in its progress through veins. Chief of these are the valves which are present, with exceptions, in veins, and permit the flow of blood towards the heart, but close if there is

any attempt at a backward flow. Contracting muscles, by pressing on veins, and, consequently, on the blood they contain, aid in the venous part of the circulation.

Besides the forces indicated in preceding paragraphs, the action of the heart, the elasticity of the arteries, the action of valves in the veins, and the effect of muscular contraction, there are others which aid in the circulation of the blood, and notably the movements of breathing, and the suction action produced by the relaxation of the heart after each contraction.

The Rapidity of the Circulation varies. It is quickest in the arteries and slowest in the capillaries. In the capillaries there is a much greater channel space, and since the quantity of blood entering the heart is always the same as that leaving it, the blood must flow more slowly in the capillaries if the balance is to be maintained. Thus from the aorta onwards to the capillaries the speed diminishes, and from the capillaries through the veins it increases to the heart. In the capillaries the rate is estimated as 1 to $1\frac{1}{2}$ inches *in a minute*, and in one of the larger arteries 10 to 15 inches *in a second.* The length of time taken for a portion of blood to travel the whole round of the circulation is, in the horse, about half a minute. It has been estimated by injecting into one of the veins of the neck a substance—ferrocyanide of potassium—easily detected by chemical tests, and noting how long time elapsed before it was found in the blood of the same vein of the opposite side of the neck.

Nervous Control of the Circulation.—The walls of the blood-vessels are largely muscular. The muscular fibres are beyond the control of the will. Nevertheless they are controlled by the nervous system, by the agency of nerves distributed among the muscular fibres. The nerves are called **vasomotor** (*vasa*, vessels), and they are governed from a centre—the **vasomotor centre**—situated in the medulla oblongata (p. 93). The influence on the vessels may be briefly stated thus: By the nervous energy continually reaching the muscular walls they are kept in a moderate state of contraction or tone, so that the channels are maintained at an average size. If the vasomotor nerves are stimulated more than usual, the muscular walls contract more, the size of the channel is diminished, the quantity of blood flowing through it is correspondingly diminished, and the supply to the part lessened. If the stimulus is less than usual, the amount of contraction is lessened, the vessels dilate by the force of blood within them, the channel becomes widened, and the supply to the part is increased. Now various influences from various parts of the body, or from the brain itself, may reach the vasomotor centre and excite it to increased activity; the nerves are thereby stimulated and the vessels contract. But there is another curious effect that may be produced on the centre, what is called an *inhibitory* or restraining effect, whereby the ordinary influence of the centre is, for a time, suspended, the tone of the vessels becomes diminished, and their channels immediately widen. The production of blushing and pallor is thereby explained.

Blushing is caused by some emotion which acts on the vasomotor centre and diminishes its activity. The tone of the vessels being lessened they dilate, more blood rushes along their channels, and the skin becomes redder and hotter by the increased quantity of blood. It is usually in the face that this is manifested.

Pallor is just the reverse condition. Some emotion so acts on the vasomotor centre as to increase its activity. The blood-vessels contract, less blood flows through them, and the part becomes pale. Thus the same emotion that causes redness of one person's face may produce paleness of another's.

More than this, the heart and the blood-vessels are related by nervous communication in a curious way. Connected with the heart there is a nerve called the **depressor** nerve. Suppose the blood-vessels in a considerable part of the body to be unduly contracted. Blood flows through them less easily, and the heart has more work in forcing it along. This may occur to such a degree that the heart is unnecessarily burdened. Its labour may become so heavy as to threaten fatigue, and danger of exhaustion may arise. At this period an influence passes from the heart by the depressor nerve to the vasomotor centre. The action of the centre is restrained, the tone of the vessels is diminished, by the pressure of blood within them they dilate, the blood flows along easily, and the heart is relieved. This is just an instance of how all the bodily functions are regulated and controlled by the nervous system, and made to serve the good of the whole body.

Section VIII.—THE BLOOD AND THE CIRCULATORY (HEART AND BLOOD-VESSELS) SYSTEM.

B.—ITS DISEASES AND INJURIES.

Diseases of the Blood:
- *Anæmia (Bloodlessness, Poverty of Blood)*;
- *Plethora (Full-bloodedness)*;
- *Leucocythæmia (White-cell Blood)*;
- *Blood-Poisoning (Septicæmia, Pyæmia)*;
- *Scurvy (Scorbutus)*;
- *Purpura;*
- *Tendency to Bleeding (Hæmorrhagic Diathesis, Hæmophilia)*;
- *Worms in the Blood (Filaria Sanguinis Hominis).*

Diseases of the Heart:
- *Inflammation of the Outer and Inner Lining Membranes (Pericarditis* and *Endocarditis)—Valve Disease;*
- *Overgrowth (Hypertrophy), Wasting (Atrophy),* and *Degeneration*—Fatty Degeneration;
- *Palpitation* and *Fainting (Syncope)*;
- *Angina Pectoris (Breast-pang)*—Neuralgia of the Heart;
- *Cyanosis (Blue-disease).*

Diseases of the Arteries:
- *Inflammation* and *Degeneration of Arteries, Aneurism;*
- *Thrombosis* and *Embolism;*
- *Wounds.*

Diseases of Veins and Capillaries:
- *Inflammation of Veins (Phlebitis)*;
- *Varicose Veins;*
- *Blood-vessel Tumours (Angeioma, Nævus,* or *Mothers' Mark)*;
- *General Features of Inflammation.*

DISEASES OF THE BLOOD.

In the first division (A) of this section an effort has been made to emphasize the fact that the condition of the blood is affected in two ways: (1) by what is added to it, and (2) by what is taken from it. It has been pointed out that additions to it consist in what it receives from the alimentary canal in the shape of food, what it receives in the shape of lymph, what it receives in its course through the body from the tissues with which it comes in contact, and what it receives from the lungs in the shape of oxygen gas, not only nourishing substances, that is to say, but waste substances also; and that substances are removed from it by the tissues for their nourishment, and by the lungs, liver and bowels, kidney, and skin, to be cast out as waste matters. The importance of recalling these facts consists in this, that the causes of diseased conditions of the blood may be classed under two similar general divisions. For disease may be occasioned in the blood (1) by the nature of the food, by the lymph (by the absorption, for instance, of poisonous material from a wound, see p. 203), by substances picked up in the progress of the blood through diseased tissues, and by gases, &c., inhaled by the lungs; or (2), from the other side, by the lungs, kidneys, liver, bowels, or skin failing to separate waste matters, which are thus allowed to accumulate in the blood and impair its quality. The same thing is expressed, in a still more general way, by saying that disease of the blood may be due to something affecting (1) its quantity, and (2) its quality. Thus there may be too little blood in the body, in which case there arises the condition of bloodlessness (*anæmia*) or poverty of blood, or there may be too much blood in the body (*plethora*), full-bloodedness; while, again, the blood may be sufficient in amount but of bad quality, as it is in scurvy and other diseases. These considerations will be best understood by those who have carefully studied the description of the blood and its functions given in preceding pages.

We shall first consider the two diseases that have been named as connected specially with the quantity of blood, and afterwards those in which quality is directly affected.

Anæmia (*Bloodlessness, Poverty of Blood*).—The word anæmia is exactly translated by bloodlessness. It is derived from two Greek

words, *an*, want of, and *haima*, the blood. It essentially consists in a deficiency of blood, and specially of certain of its constituents, the corpuscles and albuminous elements. So marked is the diminution in the number of corpuscles in typical cases that it may be recognized in a drop viewed under the microscope. One form of it is specially a disease of young women, and is called **chlorosis** (Greek *chloros*, green) or **green-sickness**, because of the peculiar hue of the skin produced by it.

The condition may be produced by loss of blood, in young women, for example, by excessive discharge during the monthly periods, or in persons subject to bleeding piles, by bad or insufficient diet, and by other diseases, such as cancer, tubercular disease, and syphilis, and by various other causes not well understood.

Its **symptoms** are paleness of the skin, the pallor being strikingly marked in those parts which are naturally ruddy, such as the lips, weakness, attacks of faintness and breathlessness, palpitation, giddiness, loss of appetite, flatulence and indigestion, quick weak pulse, and nervous symptoms, such as lowness of spirits, listlessness, irritability of temper, neuralgia, &c. In girls hysterical attacks are common. Two noticeable symptoms are headache and impairment of sight.

Treatment, except in pernicious forms of the disease, is usually successful. It consists in arresting any unusual loss of blood, in the use of proper and sufficient food, and in attention to other ordinary conditions of health, good air, exercise, sleep, &c. The principal drug given in the disease is iron. This may be given in the ordinary way with quinine, as quinine and iron tonic, or in pill combined with phosphorus and nux vomica (see p. 113). Chemical food may also be used, and other similar preparations, beef and iron wine, &c. A valuable preparation is that of dialysed iron, of which 10 to 15 drops are taken in water four or five times daily.

Most iron preparations blacken the teeth, and they should, therefore, be taken through a straw, and the mouth well rinsed afterwards.

Plethora (*Full-bloodedness*) is the opposite condition to anæmia. It is also called **hyperæmia**, from Greek *huper*, signifying excess, and *haima*, the blood. The blood contains excess of red corpuscles, is, in short, over-rich.

Symptoms.—Full-blooded people are easily recognized by their florid colour and stoutness. They are usually troubled with giddiness, because of excessive quantity of blood in the head. The pulse is full and strong. The veins of the surface of the body are visibly distended. The capillary blood-vessels are in a similar condition, and there is, therefore, a tendency to bleeding, apoplexy, &c. There are laziness and listlessness, a sense of restriction, a dull condition of mind, and tendency to sleep. The liver is usually sluggish, and the results of that condition are apt to arise (see p. 195). Plethoric people are commonly addicted to indulgence of the appetite in eating and drinking.

The **treatment** is clearly indicated. It consists in plain and temperate living, and avoidance of rich and fatty foods, of beer, wines, and spirits. Besides this, active measures should be employed to reduce the condition, vigorous exercise, and the frequent use of medicine to unload the liver and bowels. The best medicines for this are saline purges, epsom and seidlitz salts taken early in the morning, or some of the mineral waters. It is in full-blooded persons that, in threatened attacks of apoplexy or in feverish and inflammatory conditions, congestion of lungs, &c., bleeding proves specially relieving.

Leucocythæmia (*Leukœmia—White-celled Blood*) is derived from Greek words *leucos*, white, *kutos*, a cell, and *haima*, the blood, and literally means white-celled blood. This indicates the chief feature of the disease, which is an excessive production of the white corpuscles of the blood. These should exist in the blood in the proportion of 1 to every 600–1200 red ones; but in this disease they may come to equal or exceed the red corpuscles in number. Accompanying the chief feature is enlargement of the spleen, which, from being as a rule less than half a pound in weight, may come to weigh many pounds. Enlargement of the lymphatic glands and affection of the marrow of bones are also common during the progress of the disorder. The excessive number of the white corpuscles, and the enlargement of the spleen and lymphatic tissues are associated, such tissues being supposed to have to do with the manufacture of the white corpuscles. The causes of the disease are not known, though in a considerable number of cases exposure to marsh poison has been connected with it. Men are more liable to it than women, and between the ages of twenty and fifty.

The chief **symptom** is the great increase in the number of white corpuscles, which can only be ascertained by microscopic examination of the blood. As one would naturally expect, the diminution of the coloured corpuscles affects the

colour of the blood, so that the person becomes pale. The enlargement of the spleen reveals itself by fulness of the belly, and, when it is considerable, the person is himself able to detect the presence of a large solid heavy mass extending downwards on the left side from under the ribs towards the groin. It is unaccompanied with pain. Increasing weakness and shortness of breath are marked. Bleeding is not uncommon, especially from the nose, but it may cause death by occurring in the brain, or it may be in the nervous coat of the eye affecting sight. Feverish attacks, dropsy, and other symptoms may also be present. Death occurs within a year or two, either from weakness or because of bleeding or other complication.

Treatment is directed towards maintaining the patient's strength by food, fresh air, and tonics like quinine and iron, and phosphorus.

Blood-poisoning (*Septicæmia*, from Greek *sepo*, to putrefy, and *haima*, the blood; *Pyæmia*, Greek *puon*, pus, matter, and *haima*, the blood) is a disease due to the introduction into the blood of poisonous materials of a particular kind. The poison is produced by minute living things always found in abundance in the matter of unhealthy sores. (See CONTAGION, p. 384.) It is commonly in cases where such wounds or raw surfaces exist that the disease arises. Thus it is attendant on surgical operations; its occurrence is feared in cases of accident where injuries of any extent have resulted; it is frequently the cause of death in cases of dissection wounds, carbuncle, erysipelas, and in suppurations involving bone, &c.; and it is one of the most terrible and fatal occurrences after childbirth. (See PUERPERAL FEVER.) To take the last case, the separation of the after-birth (placenta) leaves a large raw surface in the interior of the womb. If the after-birth has not been completely removed, and if a small piece remains attached, it begins to decompose and break down. This is nature's way of getting rid of it. But this decomposition is attended with the formation of unhealthy material, which easily gains entrance to the blood, and produces the symptoms of the disease. The septic or poisonous matter seems to be formed at the wound and to be absorbed, and, as has been said, the septic material is the product of certain minute living things (bacteria, p. 387) found in a womb in such a condition. The word **pyæmia**, which literally means pus (matter) in the blood, is often used to signify the same condition. It means rather more. The poison of septicæmia is of a very subtle kind, not visible even with the highest microscopes, but in pyæmia there is an actual transference along the blood-vessels throughout the body of minute pellets of poisonous material, which come from the place where the unhealthy action is going on. These pellets, carried along in the current of the circulating blood, easily pass through the large arteries, but when they reach the very minute arteries they cannot pass along them. These arteries, therefore, become blocked by the poisonous material, and abscesses form wherever this occurs. Now the pellets are distributed to every organ of the body, to lungs, liver, kidney, brain, &c., in all which situations spots of inflammation and abscess arise. How serious such complications are may be imagined.

Symptoms.—The first occurrence usually is a fit of shivering, lasting for some time and followed by severe sweating, after which the person seems to get better; but another prolonged shivering occurs, followed again by sweating; and so on. The fever runs very high, diminishes considerably after the sweating, but after a few days usually keeps high. The patient after a day or two begins to have a sallow look, and to be dull and heavy. The pulse is quick and weak, the tongue brown and dry, and the lips parched. Vomiting occurs and perhaps looseness of bowels, and what is passed is dark and very badly smelling. The breathing is quick and shallow, cough often arises, and pain and tenderness of the belly may be present. In severe cases of pyæmia little patches of inflammation and suppuration may be seen on the fingers or toes or on various parts of the surface of the body. The occurrence of delirium of the muttering sort is a very grave sign. In the beginning of it the person's hands wander aimlessly about picking at the bed-clothes, and it passes into unconsciousness as death approaches.

The disease is very fatal, and especially the pyæmic form.

Treatment is in very many cases of little avail. The main thing is to keep up the person's strength by nourishing food in fluid form, concentrated soups, beef-tea, milk, &c., and stimulants in small quantities repeated as often as seems desirable. At the beginning a good dose of saline medicine seems to relieve—seidlitz powder, for example. To diminish, if possible, the fever, 5 to 10 grain doses of quinine should be given every six hours. Opium is often used to relieve pain and other symptoms, but it is a drug whose administration should be controlled by a medical man.

Any unhealthy wound, &c., should receive attention, as it may be the source of the disease. Indeed anyone suffering from a wound, erysipelas, inflammation of bone, &c., seized with shivering and sweating, should lose no time in summoning a doctor.

It is of the utmost importance to observe that the poison of septicæmia and pyæmia may be carried from one person to another, especially in the hands, &c. Therefore, the patient should be kept strictly clean, in a well-ventilated room; all discharges, as well as clothes, &c., stained with them, should be disinfected by a solution of chloride of lime, and the attendant's hands should be frequently washed in Condy's Fluid and with carbolic soap.

Scurvy (*Scorbutus*) is a disease due to an altered condition of blood produced by the absence from the food of certain ingredients it ought to possess. What the exact ingredients are it is not easy to say. Sailors deprived of a proper quantity of vegetables in their diet and living too exclusively on salt meat are easy victims to the disease. It is not limited to sailors, however, for a scurvy condition may arise on land among ill-fed persons in times of want, and it has broken out among armies in the field.

Its **symptoms** are a pale, sallow, or muddy complexion, disinclination to exertion, and lowness of spirits. There are rheumatic pains in the back and limbs. The appetite is not affected, but the bowels are bound. The tongue is large and flabby. In fact these preliminary symptoms are similar to those of anæmia, already described. Characteristic signs of the disease soon appear, such as reddish-brown spots on the skin, first of the legs, then on the rest of the body. They are like flea-bites, and are, indeed, produced by the escape of small quantities of blood from small vessels. **Petechiæ** is the term applied to them. Blood may escape in large quantity, and give the appearances of a discoloration due to bruises. Puffy swellings also occur, specially about the elbows, knees, lower parts of the leg, the angles of the jaws, and about the eyes. The gums swell, become spongy, deep-red in colour, and are easily made to bleed and ulcerate. The breath smells very foul, and the teeth become loose in their sockets. Great muscular weakness, faintish attacks, dropsy, looseness of bowels, delirium, &c., occur in advanced stages of the disease. Death arises from exhaustion or loss of blood.

The **treatment**, if well directed, may restore persons apparently hopeless, and that with considerable rapidity. It consists in supplying to the food the ingredients that have been absent from it. This is done by the use of fresh vegetables, potatoes, carrots, turnips, green vegetables, oranges, lemons, &c. Lime-juice also is a valuable restorative. One or other of these kinds of food must be added in considerable quantity to a diet otherwise nourishing. Meanwhile the person must rest for a time till danger of fainting or attacks of bleeding has passed away. The English Board of Trade now compels emigrant ships to carry a certain quantity of vegetable diet for each person, and sufficient lime-juice to supply 3 ounces weekly to each person. Merchant ships are also required to carry lime-juice for the crews, each man to receive 2 ounces weekly, and more if signs of scurvy appear.

Purpura is attended with escape of blood beneath the skin and mucous membranes, and is, like scurvy, due to a bad condition of blood. It may occur at any age, but it occurs specially among young children, and not only the badly-fed but the healthy-looking may be attacked.

The **symptom** because of which the disease is named is the occurrence of spots in the skin of a deep-red colour, from mere points in size up to circular spots one-fourth of an inch across. The spots do not fade when pressed, and are not raised above the skin. The colour, at first deep-red, fades and becomes bluish, yellowish, and finally disappears just as the blue marks of a bruise fade. They occur usually on the legs. In severe cases large bleedings may occur not only under the skin but in the mucous membrane of mouth, nose, stomach and bowels, bladder, womb, &c.; and the loss of blood thus occasioned may be so great as to produce great pallor, headache, fainting. The disease may occur suddenly among the apparently healthy, but it also frequently declares itself after preliminary symptoms of headache, weakness, and languor, loss of appetite, and rheumatic-like pains in the limbs, lasting one or more weeks.

Treatment is in some cases not necessary, good food, quietness, and rest being all that is required to complete recovery in a week or two. What medicines are best in severer cases is not certain. Tonic treatment, however, it ought to be. Quinine and iron may be used, or quinine (2 grains for each dose) with dilute hydrochloric acid (10–15 drops) taken in water three or four times a day. Arsenic is also used, but it should not be employed without medical advice. At-

tacks of purpura may return. Therefore attention should be given to the diet, which should be of a mixed kind, with, that is, both vegetable and animal food.

Tendency to Bleeding (*Hæmorrhagic Tendency, Hæmophilia*).—This is an inherited condition in which bleeding, very difficult to stop, is apt to occur for very slight reasons. It is handed down chiefly by the females of a family, but is manifested specially by the males. Families in which the tendency is exhibited are called "**bleeders.**"

The bleeding may occur from any part of the body—nose, throat, lungs, stomach and bowels, bladder, &c., as well as into the skin. It may be provoked by a pin-scratch, a leech-bite, extraction of a tooth, &c. Bloodlessness may be a consequence of repeated attacks. Painful swellings of the larger joints are also liable to trouble persons affected with the tendency. Death may be occasioned by bleeding into the brain.

Treatment consists in taking care to avoid any occasion of exciting an attack, caution against accidents, injuries, &c. If bleeding arise it must be stopped, if possible, by means of pressure on the part, or where the part cannot be reached, by the use of such remedies as are ordered for bleeding from the stomach (p. 161), bleeding from the lungs, &c.

Worms in the Blood (*Filaria Sanguinis Hominis*).—Some years ago (1870), a worm of microscopic size was found in the blood of persons suffering from a disease called **chyluria**, in which the urine is milky, due to the presence of chyle (p. 200) in it. Researches made by various observers since then have shown the presence of such parasites in a considerable number of cases. They seem to exist specially in the lymphatic vessels, which may become blocked by them or their eggs, swelling and overgrowth of the part below the place of obstruction resulting, the swelling being independent of inflammation. From the lymphatic vessels the worm, which is of the thread class, may find its way into the blood, and so be distributed throughout the body. It is in tropical countries that the disease occurs. The parasites may exist in large numbers without producing symptoms of their presence. There is no treatment for their destruction known.

DISEASES OF THE HEART.

"Heart Disease" is a term which conveys a very serious meaning to most persons. Apart, however, from the fatal termination it is commonly held to indicate, it implies nothing definite to the popular mind. It is indeed a very vague phrase, for, as we shall see, heart disease may exist in a great variety of forms, some of which are not nearly so serious as others. Either the double bag (*pericardium*) which envelops the heart, or the heart substance itself, or its valves, may be the seat of disease; and the general term "heart disease" includes unusual conditions in any of these. It will be necessary, therefore, to consider the principal affections of the pericardium, of the heart substance, and of the valves.

Inflammation of the Outer and Inner Lining Membrane: Valve Disease.

Inflammation of the Pericardium (*Pericarditis*). — The position and character of the outer lining membrane of the heart have been briefly noted on p. 219. It has been pointed out that it is in a double layer, the layer in direct contact with the heart being separated by a slight interval from the outer layer, a small amount of serous fluid existing in the space. Now when the membrane becomes inflamed the blood-vessels enlarge, becoming more full of blood, in consequence of which thickening of the membrane takes place. There oozes from the vessels on to the free surfaces of the membrane a fluid which coagulates—lymph; and thus the surfaces which oppose one another, instead of being smooth and glistening, become irregular and roughened because of the newly-formed deposit. The two layers ought to glide easily and noiselessly over one another with the movements of the heart, but, owing to the roughening, friction is produced, and a grating sound may be heard on applying the ear to the chest over the heart. Part of the fluid from the over-full vessels is not coagulable—serum; and it collects in the space between the two layers. It may become so abundant as to separate the layers completely from one another, in which case, of course, friction ceases. In some cases its quantity is so great that the heart is actually surrounded by a bag of fluid, giving rise to what might be called **dropsy of the heart.** If the inflammation abates at this stage, the vessels of the inflamed membrane begin to recover their usual size, fluid ceases to escape from them, and then a process of recovery sets in, in which the fluid begins to be absorbed by vessels—both blood-vessels and lymphatic vessels. The quantity of fluid surrounding the heart slowly di-

minishes till again the layers come into contact, friction is again produced, and the sound of it again heard. Finally the roughened surfaces adhere and become firmly connected to one another, so that they become fused and a space between them no longer exists.

This is a species of cure, there is no doubt, but the adhesion of the layers of the pericardium is too apt to lead to the development of disordered conditions of the heart at a later stage of the person's life.

Instead of taking a simple course like this, the disease may be complicated by the formation of matter in the sac of the pericardium, and may continue in a chronic form for a longer period than the acute attack lasts.

The **cause** of the disease may be simply exposure to cold, or injury, such as a wound would readily produce, or it may be due to the extension of inflammation from some other organ like the lungs. Frequently, moreover, it occurs as a complication in other diseases, specially acute rheumatic fever, disease of the kidneys, St. Vitus' Dance, scarlet fever, pyæmia, &c. In a case of rheumatic fever the inflammation usually does not only affect the outer lining membrane of the heart, but the inner as well.

Symptoms.—There are pain and tenderness in the region of the heart, and extending from that part to the left shoulder and down the left arm. Fever is also present, with loss of appetite and dry tongue. The patient wears a peculiar look of distress, has a dry cough, and a catch in the breath. The pulse is at first full and strong, but later quick and weak. When much fluid has accumulated in the sac the pressure it exerts on the gullet behind may produce difficulty of swallowing. Rambling and delirium are occasionally present.

Death may result from the pressure of the accumulated fluid surrounding the heart—from the dropsy—the heart being unable to continue its work under the burden; and then it is sudden. Recovery in severe cases is usually slow, and the difficulty of breathing, quick pulse, &c., disappear very gradually.

Besides these symptoms there are others whose value and meaning are only appreciated by those who have had a medical education. One is the friction sound, already alluded to, heard by applying the ear to the chest over the region of the heart, or by listening with a stethoscope, the instrument used for sounding lungs and heart. It is due to the rubbing of the inflamed surfaces of the membrane on one another. Other signs are obtained by percussion, as described on p. 191. The percussion is performed on the chest, a clear, hollow sound being obtained when the chest is percussed over the lungs, the sound being dull when the tapping is over the heart. The area, indicated on Fig. 116, p. 219, as occupied by the heart, will give out a dull sound; but where the pericardium is filled with fluid it will be caused to bulge out by its contents, and the limits of dulness will thus become much more extensive, because the sac filled with fluid will give out a dull, dead sound. In this way a trained person may discover whether much or little fluid has been poured out by the inflamed membrane.

Treatment.—If the inflammation arise as a consequence of another disease, that other disease must be treated. The special treatment directed to the heart may take the form of bleeding by placing several leeches on the chest. This, of course, would only be adopted by medical advice, and it would be applied only in acute attacks of otherwise strong persons. Blisters over the heart, iodine paint, and poultices, &c., are also employed. Stimulants are required if weakness is great and there is a tendency to faintness. Other drugs are also useful to relieve pain, or to diminish the action of the heart, but they are dangerous except in skilled hands.

Diseases of the Valves of the Heart.—The inner lining membrane of the heart (endocardium, see p. 220) is even more liable to inflammatory affections than the pericardium, and the term **endocarditis** is the scientific term applied to them. It is, however, usually the valves that specially suffer (as we have seen, p. 220, they are formed partly by folds of the endocardium), and, on this account, we shall consider the affections under the special heading DISEASES OF THE VALVES.

The nature of the disorder is also akin to that which affects the outer lining membrane. The blood-vessels of the valves are congested and the substance of the valves becomes thickened. Coagulable material is also deposited on them; and warty growths form in consequence. The results of this are various. The thickening and growths on the valves prevent their free play, and hinder the due performance of their all-important duties. Moreover, they become puckered and contracted, so that they are no longer able completely to close the passage which it is their business to guard. They may also become so rigid and unyielding as to offer a permanent obstruction to the free passage of the blood in the direction in which they ought

to be freely open. Standing out at an angle from the wall of the passage, and refusing to bend from this position, they bar to a greater or less extent the flow of blood past them. This rigid attitude may be the result, not only of inflammatory thickening, but also of the deposit, within the substance of the valves, of chalky matter which makes them hard and inelastic, a condition apt to arise in old age and to affect not only the valves but also the walls of the arteries throughout the body. Now what must be the effect of such states as these? It can only be properly understood by reference to the functions of the valves, as already described on p. 221. Take the left side of the heart, for it is in the valves of the left side that the disorder is commonest. We have seen that there are, on this side, two valves. There is the mitral valve between the upper and lower chambers, which is open on the contraction of the upper chamber to permit the blood to be driven into the lower, and which, as soon as the lower chamber contracts, closes to bar the return of blood to the upper chamber. Suppose, first, that this valve has become contracted and too small properly to close the passage. Then it is plain that when the lower chamber contracts, the communication between it and the upper one not being completely cut off, all the blood is not driven into the vessel (aorta) that rises from the ventricle (the lower chamber), but part passes back again into the auricle, which thus becomes overfull because it receives back part of the blood which it had, but an instant before, sent onwards. Suppose, again, that the valve is standing out rigidly in the fair way, then, when the auricle contracts, the blood is obstructed in its passage downwards to the ventricle, and it is hard work for the auricle to get itself thoroughly and quickly emptied. The second valve on the left side is at the place of communication between the ventricle and the great artery springing from it—the aorta, and when the ventricle contracts the blood should be propelled into the artery, and the valve should thereafter close to prevent it returning again to the chamber (see p. 222). If the valve is incompetent, that is, if it does not properly close the opening, when the ventricle is relaxing the valve does not completely hinder the blood returning and part of it pours back to the ventricle. Thus it is never properly and satisfactorily emptied. **Regurgitation** is the term applied to the return of blood in this way. If, again, the valve be rigidly standing out from the wall of the aorta, the blood driven out of the ventricle does not find a free passage, it is delayed in its exit, and the heart has to contract more vigorously to overcome the resistance.

Any of these disturbances of the circulation through the heart cannot exist without changes being produced in the heart itself. Whether it be that there is an obstacle to the flow of blood through the heart, or that part of the blood, that should pass onwards, returns, the first effect on the heart, and specially the chamber first affected, is that it begins to enlarge. This is partly because it works harder to perform its task, which has become more difficult, increase of growth occurring to meet the increased demand for energy, and partly because the increased quantity of blood always in it produces a distension of the walls to afford increased accommodation. The heart enlarges in its substance, that is, it suffers **hypertrophy** (overgrowth), and it also suffers **dilatation** (overdistension). But the changes are not limited to the heart; they in time affect the whole body. If the ventricle becomes overfull, because of disease of the valves of the aorta, that will speedily produce a similar condition of the upper chamber, the pressure passing backwards. Since the auricle receives its blood from the lungs (p. 223), and since the blood does not get passing onwards quickly enough, the lungs will, by and by, begin to feel the backward pressure, and become more or less blocked with blood also. Since the lungs receive the blood from the right side of the heart, the pressure will travel backwards to the chambers on that side, and they in turn will become overfull. Moreover, the blood arriving in the right side of the heart comes from the head and neck, some of it directly from the liver and also from the trunk and lower part of the body, and that coming from the liver is the blood from the stomach and bowels, &c. The blocking will, therefore, travel ever backwards and backwards to these organs, so that the veins of head and neck, liver, stomach, &c., will become congested. Just as, if you have a large number of streets and lanes opening into a main thoroughfare, along which crowds of people are streaming, if one end of the main thoroughfare becomes partly blocked and the crowds still stream on, that thoroughfare will speedily become blocked from one end to the other, and then the lanes and adjoining streets will in turn become crowded with the people who cannot get on. Of course if the people could be made to pass off some other way the blocking would soon be got rid of; but the blood must all go on in the destined course,

there is no side way by which it can escape, and as time goes on the congestion becomes worse and worse. Another thing to note is that while the veins bringing the blood to the heart all become unduly full, the arteries do not contain sufficient blood, because the blood is not escaping in a full enough stream from the left side of the heart, and thus the various organs cease to be duly nourished, while at the same time they are congested with blood. Thus it becomes clear how, from valvular disease of the heart, congestion of the lungs, liver, kidneys, stomach and bowels, brain, &c., arises, and how consequently shortness and difficulty of breathing, with an attendant livid hue of the skin, jaundice, indigestion, kidney disease, headache, giddiness, convulsions, &c., may be occasioned. Moreover, fluid oozes out of the overcharged veins and dropsies arise. Meanwhile the heart itself suffers from defective nourishment, and its labour becomes too great for its strength. It becomes weakened, and with its commencing failure the consequences of its disease are at once aggravated.

Now while such is a sketch of the consequences of an aggravated case of valvular disease, it is not to be supposed that all cases of valve disease run a similar course. Such is very far from the truth. There is no manner of doubt that many people have some imperfection of the valves of the heart and never become aware of it, but are able to lead active lives without being aware of any symptom that leads them or others to suspect any unusual condition of the heart. An average length and an ordinary vigour of life are not inconsistent with some forms of valvular disease. That is why doctors frequently refrain from informing patients of such a condition they may know to exist there. For heart disease is a phrase of terror to many, and the knowledge that they were, in even the smallest sense, subjects of it would seriously affect their lives, while they might live long and useful lives in blissful ignorance, and die, perhaps, of some disease entirely unconnected with disorder of the heart. Further, though sudden death is a result of some forms of disease of the valves, it is not so common as was at one time supposed.

Another result of affection of the valves remains to be mentioned. The roughened condition of the valves sometimes causes fibrin to be separated from the blood, and to be deposited in little clots on their edges. The clots may become detached and swept away in the current of blood. They pass easily through the larger vessels but at last reach vessels too small to permit their passage, which they block up. This blocking of small vessels by detached clots is called **embolism** and is referred to on p. 246. Sudden death is a common result of this, a clot, finding its way to the brain, and blocking a vessel, cuts off the blood supply to a part of the brain, and sudden paralysis or unconsciousness is the result.

The **causes** of the disease are acute rheumatic fever in particular, St. Vitus' Dance, scarlet fever, Bright's disease of the kidneys, syphilis, &c.

Symptoms.—General symptoms have already been indicated in the sketch given of the results, affections of the lungs, congestion, bronchitis, &c., with attendant lividness of the skin, difficulty of breathing, jaundice, indigestion, disease of the kidneys, with scanty, high-coloured urine, and nervous symptoms, headache, giddiness, &c. Connected with the heart itself there are things to be noted. The beat may be feeble or excessive, and it may be irregular. *Palpitation*—frequent, sudden, and violent beating of the heart is common. But it must not be forgotten that palpitation, irregularity of the heart's beat, and a form of irregularity, called intermission, in which a beat is missed and the person feels a throb or tremble or fluttering sensation, perhaps with a feeling of choking, are far more commonly due to indigestion, specially indigestion with flatulence, than to heart disease. Many people, particularly women, are convinced they suffer from heart disease because of palpitation and the very uncomfortable sensations it produces, when all the time there is nothing but a stomach derangement to blame.

The special signs of disease of the valves of the heart, whose discovery alone justifies one in declaring the disease to exist, are such as a person cannot easily detect in himself. They are found by an examination of the chest, and by listening to the sounds produced by the contracting heart. A physician will find at what part of the wall of the chest the heart beat is felt most distinctly, and will see whether it is in the right position; he will examine by percussion—by tapping the chest as indicated on p. 191—to determine whether the heart is the usual size or is enlarged; and he will employ auscultation—that is he will listen with his ear to the chest wall or by means of the stethoscope—to hear the sounds of the heart, in order to learn if they are of the usual character. For the sounds noted on p. 224 will be altered, if disease of the valves be present. If a valve

be diseased, one of the sounds will be replaced or attended by a blowing murmur, and the relation in point of time which the murmur bears to the heart sounds will indicate which valve is affected. A skilful man will exercise caution, because a temporary murmur may be produced by pressure or other circumstances, bloodlessness of the patient, for example, which might without care be mistaken for the sound of a diseased valve. In rare cases the peculiar sound has been loud enough to be heard by the patient himself and those standing near him; commonly it requires to be examined for.

The **treatment** of valve disease depends on various circumstances. If it is a complication of some other disease, rheumatism, &c., clearly that other disease requires attention. A person who has had rheumatism should exercise great care to avoid cold, draughts, wettings, &c., that would readily excite a second attack. General treatment of the disease consists in avoidance of all excitement—running, hurrying for trains, jumping, mounting long stairs, in fact everything involving exertion. Fits of anger, outbursts of emotion, &c., should equally be avoided. The bodily health should be carefully maintained by judicious eating and drinking, and over-eating, the excessive use of tea, tobacco, and stimulants, &c., should be rigorously guarded against. The health may be benefited by change of air, iron tonics, &c. If distressing symptoms, such as palpitation, difficulty of breathing, &c., arise, they will be much relieved by complete rest. Drugs, and in particular digitalis, are used to strengthen and calm the heart, but how and when they should be used ought to be determined by a medical attendant.

Overgrowth, Atrophy, and Degeneration.

Overgrowth (*Hypertrophy*) and **Dilatation** of the heart have been noted as results of valve disease. Further reference is unnecessary.

Atrophy of the heart is the opposite of overgrowth, and is a consequence of wasting diseases, such as consumption, diabetes, &c. In it the action of the heart is feeble, and the beat against the chest wall weak. The treatment is that of the bodily condition of which it is a consequence.

Fatty Degeneration of the heart is a condition of advanced life, and is produced also by acute fevers and by poisoning with phosphorus. It is also a frequent result of such inflammation as has been described under INFLAMMATION OF THE PERICARDIUM, p. 238.

In fatty degeneration the muscular fibres of the heart substance are affected. The proper substance of the fibres is replaced by oily particles, and the muscular tissue is in consequence weaker and more easily torn. The degeneration is usually in patches in certain parts of the heart's substance; these parts are weaker than others. Fatty degeneration is a cause of sudden death. The soft fibres readily give way under some strain, even though it be slight, the excitement of some sudden emotion, and a tear occurs in the substance of the heart through which the blood passes into the surrounding pericardial sac. Thus fatty degeneration is one cause of **rupture of the heart**; and the phrase "a broken heart" contains a literal truth.

The **symptoms** are those of feebleness of the heart. The pulse is weak, and the heart sounds feeble. There is general weakness, a tendency to breathlessness, giddiness, and faintness.

The symptoms of rupture of the heart are sudden severe pain about the heart, gasping for breath, fainting, and speedy, in many cases instantaneous, death.

The **treatment** of such a condition as fatty degeneration is simply such as will maintain the strength of the person as much as possible. Good nourishment, with plenty of animal food, gentle exercise, fresh air, &c., are demanded, as well as iron and similar tonics. It is plain that all excitement, worry, &c., must be avoided.

It may be noted that rupture of the heart may be produced by external violence, and that immediate death even from a wound is not invariable. The wound may be blocked by blood clot, &c., and death be delayed for hours or even a few days.

Palpitation and Fainting.

Palpitation has already been commented on (p. 241). It includes irregular action of the heart of various forms, which produces uncomfortable sensations of fluttering at the heart, throbbing, and tumbling, and is attended by other feelings of anxiety or distress, of difficult breathing, of giddiness and faintness, and so on. Motes may be seen dancing before the eyes, the feet and hands get cold, and then the face may flush up, and perspiration break out. Now it is true that palpitation with some or all of these accompanying symptoms attends some forms of heart disease. But it is equally true that it far more commonly is the result of

digestive disorders, of poverty of blood (anæmia), and of similar conditions. It is necessary to urge this very strongly, for very many people are haunted with the fear of heart disease, because of such symptoms, whose heart is perfectly sound. Nervous women are particularly liable to such forms of palpitation.

For palpitation as a symptom of goitre, see p. 211.

The **treatment** consists in attention to the diet, in the avoidance of everything that would tend to aggravate the condition, such as *excess in tea or tobacco.* Regular exercise, early hours, and avoidance of excitement should be practised. In many cases treatment for indigestion, and specially for flatulent indigestion (p. 181), is useful.

Fainting (*Syncope*, Greek *sunkopto*, to knock to pieces, *Swooning*).—In fainting there is always enfeebled action of the heart. It may be the result of nervous excitement, shock, or strong emotion, severe pain, or loss of blood. The heart's action is suddenly and momentarily suspended or greatly diminished, the blood fails to circulate properly or in sufficient quantity through the brain, and unconsciousness is the result.

The **symptoms** are paleness and coldness of the skin, faint, shallow, and sighing breathing, feeble pulse, and it may be either quicker or slower than usual, giddiness, noises in the ears, indistinctness of sight, and loss of consciousness, the person falling to the ground limp and motionless. Sickness occasionally occurs; and the skin becomes covered with drops of sweat. Recovery from fainting is usually not long delayed, and is indicated by increasing strength of the pulse, return of colour to the face, and improvement in the breathing.

Treatment.—The person should be laid flat on the back, and all tight clothing round chest and neck loosened. Fresh air should be allowed, and cold water should be dashed over chest and face. These means are often sufficient to restore within a very short time. If the fainting fit persists, smelling salts or ammonia should be held to the nostrils. The heart may be stimulated to renewed activity by rubbing over the chest and by applying a sponge, dipped in hot water, directly over it. As soon as the patient has been sufficiently restored to swallow, two or three tea-spoonfuls of sal volatile in a little water, or a table-spoonful of whisky or brandy in water should be given. If these cannot be swallowed they may, if necessary, be thrown up into the bowel by means of a syringe. In very persistent cases the heart's action has been restored by galvanism.

Apart from such immediate treatment a person liable to fainting fits should be put on a course of tonic treatment, as the general state of health may indicate.

Angina Pectoris.

Angina Pectoris means literally breast-pang. It is a very peculiar disease, and was first properly described by Dr. Heberden, who named it because of the sense of strangling in the breast, which is its chief symptom (Latin *ango*, to strangle, and *pectus*, the breast).

Its cause is not properly known, but after death the hearts of those who suffered from it have been found the seat of degenerative changes, and, in particular, the coronary arteries, which come off from the commencement of the aorta, have been found hard and rigid by the deposit of lime salts in their walls—**calcareous degeneration.**

Symptoms.—The disease attacks in spasms, and between the spasms the person may be in apparently good health. The spasm commonly comes on when the person is walking or making some slight bodily exertion. It consists in a peculiar pain felt about the region of the heart, and extending to the left shoulder and down the left arm to the elbow. The pain may be aching or numbing, or give the impression of severe tightening. Under its influence the person instantly becomes still, and is possessed with the dread of impending death. His face is pale and haggard, the skin is covered with clammy sweat, and he has a sense of suffocation, although there is no difficulty in breathing. At first, as a rule, the attack passes off in a short time, and the person is himself again. But the spasm recurs after a longer or shorter interval. Gradually the intervals become shorter and the spasms last longer, and sooner or later the person dies in an attack. Sometimes, however, long intervals occur between two attacks.

Neuralgia of the heart is sometimes spoken of. Its symptoms are those of angina. It is the term applied when no disease of the heart is found to account for the spasms.

Treatment is directed to relieving the spasm when it occurs. All that can be done to ward off attacks is to avoid exertion or straining of any kind, excitement and fatigue, and excess in eating or drinking. To relieve the spasm stimu-

lants are used, ammonia, brandy, or ether (½ to 1 tea-spoonful). Of recent years nitrite of amyl has been found specially useful—5 drops are placed on a handkerchief and inhaled. Care must be exercised in its use. Persons liable to the attack should carry a small bottle with a tightly-fitting stopper, in which is placed a little cotton with 5 to 6 drops of the nitrite on it. As soon as the attack threatens, the vapour should be drawn up into the nostrils. The nitrite is also put up in little glass beads—5 drops in each globule. When required, one is crushed between the folds of a handkerchief and inhalation practised.

Cyanosis or Blue-disease.

Blue-disease is a condition in which the blood is denied its due amount of air. As a consequence the blood never has the bright-red colour of proper arterial blood, but is purplish from the excess of carbonic acid gas (see p. 216); and thus the surface of the body exhibits a more or less livid hue. It is a common result of diseases of the lungs which interfere with the proper exchanges between the blood and the air. It will, therefore, be discussed under DISEASES OF THE RESPIRATORY SYSTEM in the succeeding section. But it is also produced by diseases of the heart, and specially by a defective condition of the heart which dates from birth. In this condition a communication exists between the upper chamber of each side of the heart. The result is that venous blood entering the right auricle, which ought to pass down to the right ventricle, and then to the lungs, to be purified before gaining the left side of the heart, passes in part straight through to the left auricle, escaping the lungs. The blood distributed to the body from the left side of the heart consists in part of blood purified by the lungs and in part of blood not so purified. This disease, being one dating from birth, is considered at greater length under DISEASES OF CHILDREN.

DISEASES OF ARTERIES.

Inflammation and Degeneration of Arteries: Aneurism.

Inflammation of the inner coat of arteries is characterized by patches of thickening due to increased cell development. The thickened patches encroach on the channel of the vessel, and may block it. The disease depends in some cases on syphilis or other bad conditions of the system, such as defective diet, intemperance, over-exposure to cold, &c., would produce. Sometimes it is a consequence of other diseases.

The **symptoms** are mainly due to the obstruction to the flow of blood. Thus the part which is supplied by blood from the vessel will be improperly nourished, and may pass into gangrene (mortification) if the vessel be blocked. Where the blocking and inflammation are due to a clot filling up the vessel pain and tenderness are felt in the line of the vessel.

Degeneration is an accompaniment of inflammation. The cell growth of the inflamed patches breaks down into fatty material, and, if this be swept away by the current of blood, an ulcer is left on the inner coating of the vessel. If the degeneration has passed deeply into the substance of the wall of the vessel, that part will be seriously weakened, liable to stretch or burst, and thus aneurism may be produced. **Atheroma** is the term applied to this degenerative change in an artery. Another form of degeneration is the calcareous. Chalky material becomes deposited in thin plates in the inner coat of the vessel, and sometimes throughout the muscular coat of the wall of the vessel as well. The vessels lose their elasticity in consequence, and become quite hard. In vessels that come to the surface the rigid tubes are easily felt by the finger, and clearly indicate what is going on.

Aneurism (Greek *aneuruno*, to widen or dilate) is a pouch-like swelling or bulging formed in connection with an artery. The **true aneurism** is formed of a part of the wall of the artery which has been unable to resist the pressure of the blood within the vessel and has slowly bulged out. This usually happens in an artery that is the seat of fatty or calcareous degeneration, by which its walls have been weakened. The walls of the sac of the aneurism are thus formed of the walls of the artery, but do not necessarily exhibit all the three coats possessed by a healthy artery (see p. 226). An aneurism may be formed in connection with a vessel by rupture of the vessel occurring, through a diseased part of the wall, for example. If the escaped blood is hemmed in by the tissues surrounding the artery, so as to form a sac, while, at the same time, the opening in the vessel remains as a means of communication, a **false aneurism** is formed. A wound from the outside may occasion aneurism in a similar way.

The causes of aneurism are thus disease of the arterial walls diminishing their power to resist the pressure of blood from within, or injury of the vessel by violence from without. Strains, excessive and sudden muscular effort, &c., may lacerate the coats of an artery and so diminish its resistance as to lead to aneurism. Men are more liable to it than women, and it is chiefly a disease of advanced life, though it does occur in the prime of life.

The usual history of an aneurism is that, being caused by a yielding of the walls of the artery before the pressure of the blood, and that pressure being constant, the yielding is apt to continue, the more because, as the sac enlarges, its walls must become thinner. As it expands it exerts pressure on the tissues and organs which are in the neighbourhood. Sometimes, owing to the pressure, neighbouring parts become matted to its walls, and do something to prevent its bursting. Within the sac also changes take place. The inner surface is rougher than the usual smooth inner lining of a blood-vessel, and the blood in the pouch may be more or less stagnant, depending on the size of opening from the artery into the pouch. Both of these conditions tend to produce coagulation of the blood. Fibrin is separated from the blood and deposited on the inner surface of the sac. This often goes on till layer after layer of fibrin is formed. In such a way it is possible for the sac to become filled up, in time, by a mass of fibrin clot, and for a cure to be effected naturally. Various causes, however, frequently co-operate to prevent such a desirable result, and as a rule the aneurism enlarges, unless means are successfully adopted to prevent it.

The **symptoms** of aneurism vary according to its position. If it is not within the chest or belly, but in the neck or limbs, it appears as a tumour. The hand placed over it detects a pulsation in time with the beat of the heart. Any tumour placed over an artery would communicate the pulsation of the artery to the hand; but a tumour apart from the artery might be pushed or lifted from the artery, when the pulsation would cease. This cannot be done with an aneurism. The swelling is from the commencement a soft one. Sometimes uniform and regular pressure will succeed in emptying the sac, and as soon as the hand is removed the blood fills it up again. If the artery be compressed between the tumour and the heart the swelling becomes relaxed. Severe pain is occasioned by pressure on nerves; veins may be obstructed, leading to dropsy; and the constant pressure will even cause eating away of a bone. Of aneurisms in the limbs the most frequent is that situated on the artery in the popliteal space, the space between the hamstring muscles behind the knee. Next comes the femoral artery in the groin. Aneurism of the carotid and subclavian arteries (see p. 227) are not uncommon. Commoner than all these, however, is aneurism of the aorta. Occurring as it does within a cavity of the body it is not so easy to recognize. Thus aneurisms occur in the chest connected with the aorta in the immediate neighbourhood of the heart, or connected with the arch of the aorta, or with one of the large vessels springing from it, or with some part of the aorta as it descends through the chest towards the belly. These are called **thoracic aneurisms.** Aneurisms also occur on the aorta in its course through the cavity of the belly or connected with one of its large branches. These are **abdominal aneurisms.**

Now aneurisms in the chest or belly may attain such a size and bulge so much forwards that they are readily recognized as pulsating tumours. Thus a chest aneurism from the arch may bulge forwards, pressing on ribs and breast-bone, and may, by its pressure, eat through the ribs and breast-bone and appear as a regularly heaving mass, perhaps pushing its way up into the root of the neck, and threatening to burst through the skin. But, on the other hand, they may not project in this way, because of their situation, and there may be no visible external sign of their presence. In such cases the symptoms of their presence are due to the pressure they are exerting on surrounding parts. Thus constant aching and shooting pain is likely to be the result of involving nerves. One of the nerves of the windpipe may be involved and loss of voice result. Pressure on the windpipe affecting breathing and producing spasmodic cough, pressure on the gullet causing difficulty of swallowing, pressure on veins leading to congestion and dropsy of some part of the body according to the vein that is obstructed, and so on, are some of the symptoms that may be produced by the aneurism. Aneurism of the arch of the aorta may also affect arteries in its neighbourhood. Thus the artery going to one arm may be obstructed, and the pulse of that arm be absent or very feeble.

Thus whether the aneurism be external or internal it will require skill and experience to determine its true nature.

Treatment. — The treatment of external aneurism (aneurism not within a cavity of the

body) is more simple than that of the internal variety. It naturally requires a surgeon, but various methods may be adopted. One method is to compress the artery nearer the heart than the aneurism, so as to delay the flow of blood and provoke the formation of a clot; another is to tie the artery. The flow of blood is finally stopped in it, but gradually its branches above the tied part enlarge and carry on the circulation. Till that is accomplished, great care is requisite to keep the limb warm by wrapping in cotton wool, &c., lest mortification set in before the circulation is properly restored. It has been mentioned that sudden violent strain may produce aneurism, and the person often feels as if something had given way. If after such an experience a person finds a heaving tumour forming in the course of one of the arteries of the limbs, he ought to go to bed and avoid interfering with the tumour till surgical aid is obtained. In the event of an aneurism bursting, the main blood-vessel of the limb should be compressed as described under ACCIDENTS AND EMERGENCIES.

The treatment of internal aneurism cannot be conducted on such lines. The patient is kept quiet in bed, and is allowed limited diet, in the hope that the formation of a firm clot in the sac will thus be aided. Some drugs, and especially iodide of potassium, are supposed to aid this result, and opium is used to relieve pain. Where the aneurism has projected from the chest wall, needles connected with galvanic batteries have been introduced into the sac, and the current passed for a few minutes at a time. This has been done for the purpose of aiding in coagulation of the blood in the sac, and has been successful in some cases.

Thrombosis and Embolism.

These are two conditions leading to blocking up of a blood-vessel by a clot. In **thrombosis** the clot forms *at the place* where the obstruction occurs, due, it may be, to the sluggish movement of the blood in the vessel, or to some diseased condition of the inner wall, leading to the formation on it of fibrin. The clot is called a **thrombus** (Greek *thrombos*, a clot of blood). It is by the formation of a clot that a vessel that has been torn or injured becomes closed. Of course by this occurrence the continued movement of the blood in that vessel is prevented, and, if it be an artery, the nourishment of the part supplied by the vessel is defective. If it be a *large* artery mortification of the part (gangrene) is apt to arise. If the obstructed vessel be a vein, the return of blood from the part is impeded, and congestion, dropsy, &c., result.

In **embolism** the clot comes *from a distance*, and goes on in the current of the blood till it reaches a vessel too small to permit its onward progress, which it blocks. The clot is called, in this case, an **embolus** (Greek *embolos*, a plug). Its effects are similar to those of thrombosis. It is needless in a work of this sort to discuss the symptoms of either of these conditions. It may be remarked that embolism, occurring because of small clots detached from the valves of the heart, diseased by attacks of rheumatic fever, for example, are common, and lead to plugging of vessels, specially in the brain, liver, kidneys, &c. Sudden paralysis and death frequently are due to plugging of some important vessel in the brain by a clot detached from diseased valves of the heart. The part played by emboli in pyæmia is noted on p. 236.

Wounds of Arteries.

See under ACCIDENTS AND EMERGENCIES.

DISEASES OF VEINS AND CAPILLARIES.

Inflammation of Veins (*Phlebitis*, Greek *phleps*, a vein).—Veins may be inflamed owing to injury, or in consequence of dilatation (*varicose veins*) or some unhealthy condition of blood, or because of the formation of a clot (*thrombus*, see above) within them. Even if a clot be not present to cause the inflammation, the result of the inflammation will be to produce one, so that the vessel becomes blocked. Inflammation of veins sometimes occurs after childbirth.

Its **symptoms**, if the affected part can be seen, are pain, thickening and hardening, swelling, and perhaps redness in the course of the vessel. Abscesses are apt to be produced; there is considerable fever, with foul tongue, headache, &c. Congestion of veins below the seat of obstruction, swelling and dropsy of the part, are results. Then if parts of the clots be detached and carried into the current of the circulation, they will pass to various organs, blocking other vessels, and thus produce abscesses in lungs, liver, joints, &c.

Treatment, which must be under qualified direction, consists in keeping the person perfectly quiet, to diminish the risk of clots being detached, and in the administration of nourishing

food, tonics, and probably also stimulants. Abscesses within reach require opening.

Varicose Veins (Latin *varix*, a dilated vein) are veins that have become over-stretched by the pressure of blood within them. In addition the vessels become tortuous; and the dilatation is greatest in the neighbourhood of a valve, where pouch-like stretchings are formed. The veins of the lower extremities are very liable to the dilatation, and the pouched and gorged veins are seen running a very winding course, specially towards the inner side of the knee. Often also the fine branches are seen, lower down, forming here and there a blue tracery in the skin of the inner side of the leg and foot. Piles (p. 193) are a form of varicose veins.

The **causes** are various, but are largely mechanical. A congested liver and costive state of the bowels, by impeding the return of blood, and thus increasing the pressure in the veins, produce them. They are common in pregnancy, because of the enlarged womb obstructing the veins in the abdomen. Persons engaged in occupations that keep them standing most of the day are liable to suffer from them, and specially stout people.

Treatment.—A loaded state of the liver and bowels should be corrected by purgatives. Support to the vessels should be given where possible, by, for example, a well-adjusted bandage on the limb, or the use of a properly fitting elastic stocking. The pain and swelling of a limb produced by varicose veins are greatly relieved by rest with the limb supported in an elevated position.

Death from bleeding has occurred by bursting of greatly swollen veins. If a vein burst in the lower limb, the leg should be raised and pressure applied over the vessel as directed under ACCIDENTS AND EMERGENCIES.

Thrombosis and Embolism may occur in veins as in arteries, in fact in all kinds of vessels. (See preceding page.)

Blood-vessel Tumours (*Angeioma, Nævus, Mothers' Mark*).—These are growths of irregular shape formed of enlarged and dilated vessels. They may be formed mainly of arterial vessels, in which case the tumour is of a bright colour, and beats in time with the heart. If veins form the growth it is of a dark hue, does not beat, feels doughy, and is easily emptied by pressure. While, again, there may be no tumour properly so called, but simply a red patch in the skin. This is composed of dilated capillaries, and is the form to which the term *Mothers' Mark* is applied. Such marks are present at birth. In some cases they waste during early childhood, in others they spread. They occur specially in the skin and about the head.

Treatment.—If they are small and not increasing or troublesome, they should be left alone; if otherwise, methods are adopted to stop the flow of blood through them by exciting inflammation and causing destruction of the vessels, or by tying the vessels in some way. A great many means are tried to accomplish such ends; but a surgeon will adopt the method suited to the particular case.

The General Features of Inflammation.

Inflammation is the term used to describe a series of processes which occur in a tissue which has been exposed to injury or irritation. In the production of the changes that follow the injury or irritation, the blood-vessels of the part have a chief place; and the signs of inflammation apparent to the senses, namely, redness, heat, and swelling, are the direct result of the occurrences in the vessels. To understand the nature of these changes it is necessary to recall the characters of the blood and of its movement in the blood-vessels, as seen under the microscope. We remember that the blood contains red and white cells or corpuscles (p. 213), the white being few in comparison with the red; and that when the circulation of blood is seen, say in the web of a frog's foot, the blood is observed to flow in an even stream in the capillary blood-vessels easily and uniformly, the current of blood corpuscles—red and white mingled—passing along the centre of the vessel, and not adhering to its walls. Now if the part, being watched under the microscope, be irritated or injured in any way, at once a remarkable change takes place in the vessels. They widen, and an increased quantity of blood flows to them. Blood-vessels, but faintly perceived before the injury, are now very plain because of their increased size, and others, formerly invisible from their narrowness, now start into view. There is manifestly a much larger quantity of blood in the part, and this increase in quantity is accompanied by its signs of increased redness and warmth. It is also evident that the blood is flowing less quickly through the vessels; the current is delayed. To this stage in the process of inflammation the term **congestion** is applied. This is not yet inflamma-

tion. If the irritation has been slight, or has been quickly removed, the excessive quantity of blood may pass away, the vessels gradually recover their former size, and no sign of any unusual occurrence remain. But if the irritation be great or continue, the process goes on. As a result of the fulness of the blood-vessels and the pressure exerted by the blood within them on their walls, leakage takes place, and fluid passes out of the vessels into the surrounding tissues. On this account, as well as because of the large quantity of blood in the part, some degree of swelling is apparent. It is this **exudation**, as it is called, that goes to form the fluid found in quantity in such serous cavities as that of the pericardium, surrounding the heart, or that of the pleuræ, surrounding the lungs, when these membranes are inflamed, as in dropsy of the heart (p. 238), and pleurisy (p. 267). Accompanying such changes is another of remarkable importance. The observer, watching carefully through his microscope the effects of irritating the frog's web, perceives that, with the slowing of the current, the white blood corpuscles quit the centre of the stream and begin to loiter along the walls of the vessels. So that instead of a central stream of corpuscles in the vessels, with clear margins, there is a central stream of red corpuscles, but a row of white corpuscles on each side, which soon cease to roll along and adhere to the walls. They do more than this. The white cells send out processes which pierce the fine walls of the vessel, and gradually these processes widen till the cells themselves are found bodily transferred to the outside of the vessel. The curious thing is that no opening can be discerned through which the cells could pass, but, all along the capillaries of the inflamed district, white cells are seen either lying outside of the vessels or in various stages of their passage through the walls. A schoolboy will blow a soap-bubble, and will pass peas and coins through its walls without rupturing them or destroying the bubble; and we can only suppose that, in a similar way, the white cells pass through the delicate capillary walls without any breach of substance. The final stage of the inflammatory process, as regards the blood-vessels, is that the blood experiences ever-increasing difficulty in passing onwards, until at length the flow ceases altogether in the inflamed part, the vessels remaining choked with blood. This is the stage called **stasis**, that is, stoppage. As regards the tissues outside the vessels, they are found crowded with white cells, a large number of which consists of those that have emigrated, as the phrase is, from the vessels, many of them being doubtless descendants of the emigrant cells, which have the power of multiplication by division, and some being, perhaps, produced by the tissues, which share in the inflammation. The cells that have escaped from the vessels are remarkably active, exhibit the amœboid movement described on p. 214, by means of which they push their way through the tissues and wander some distance from the vessels out of which they have come. On this account they have been called "**wander-cells.**"

The issue of the inflammatory process may be of various kinds. What is called **resolution** may occur, that is, the inflammatory process may cease, the circulation in the vessels being slowly restored and the excess of blood being carried off, while the cells and fluid that have escaped pass into lymphatic vessels (p. 203), and the part resumes its normal size and appearance. Again, the material that has passed into the surrounding tissues may not be removed by the lymphatic vessels, but may remain and be transformed into a low form of tissue; that is to say, **organization** occurs, permanent thickening of the part remaining. Or again, the material may degenerate and break down, particles of the inflamed tissue sharing the same fate, and **suppuration** results, the broken-down material forming matter. Finally the blocked blood-vessels and the pressure on the tissue may cause some of it to die in mass. Such an issue is called **gangrene**, or mortification. In the parts surrounding the inflamed region the circulation is more active than usual, and if any destruction of tissue has occurred a process of repair will be found going on alongside of it. The healthy side of the tissue brings down blood in sufficient quantity to set agoing and maintain more or less vigorously a process, designed to repair the breaches that have been made by the inflammation.

We see that the starting-point of inflammation is an injury or irritation, in short, damage is done to the tissue. Excessive heat or cold may be the cause of the damage, mechanical injury, or injury by chemical agents. For instance, a wound may be the cause, or irritation by the burning of some acid, and so on. The extent, and severity, and duration of the process will depend on the nature of the damage and the length of time the irritation has acted. As a rule continued inflammation means the continued operation of an irritant.

The **general treatment** of inflammation may

be indicated here, though the details of the treatment will depend on the seat and character of the inflammation. Naturally the first thing to do is to remove the irritation if it be still present, or to diminish as much as possible its activity, if removal is not possible. Then *in the early stage* inflamed parts are best treated by cooling or cold applications. These, if applied at the right time, may, by contracting the blood-vessels, greatly diminish the quantity of blood flowing to the part, and lessen the severity of the attack. If applied at the wrong time, however, when the process is advanced, they are liable to do grievous damage by impairing the vitality of the part already lowered by accumulated blood. In such a case the judicious application of heat—hot cloths, &c.—will relieve the part by helping on the stagnating blood, and by stimulating the lymphatics to remove the material poured out. In no case, while the process is going on, should rubbing, either alone or with liniments, be resorted to. It only irritates. The proper time for this is when inflammation has ceased, and when the part needs stimulating to help it in its task of removing excess of material laid down, and of restoring its depressed activity. Above all, while the inflammation is present the part should be kept strictly at rest, and if it is a limb that is affected it should be raised, to help the return of blood to the heart and diminish the quantity passing to it.

Section IX.—THE RESPIRATORY SYSTEM (AIR-TUBES AND LUNGS).

A.—ITS ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Apparatus of Breathing:

- *The Windpipe* or *Trachea*—the larynx and epiglottis;
- *The Bronchial Tubes;*
- *The Lungs*—their air-cells (*alveoli*)—their investing membrane (*pleura*)—their blood-vessels—their position in the chest;
- *The Diaphragm.*

The Movements of Breathing:

- Their *nature*—inspiration and expiration; their *rhythm* and *rapidity;*
- Their *cause* in ordinary quiet breathing and in forced breathing;
- *Varieties of breathing*—abdominal or diaphragmatic, costal, and facial breathing;
- *Results of the movements*—the introduction of air into the chest—tidal, complemental, supplemental, and residual air—vital capacity of the chest;
- *The nervous control* of breathing.

The Purpose of Breathing:

- *The gases of the blood;*
- *Exchanges between the blood and the air* in the lungs—diffusion of gases;
- *Exchanges between the outside air and that of the air-cells*—composition of air breathed in and of air breathed out—amount of oxygen consumed in the lungs daily and amount of water and carbonic acid gas given out.

Ventilation:

- *Its necessity;*
- *Results of improper ventilation*—asphyxia.

Artificial Respiration:

Modified Respiratory Movements:—

- *Coughing; Sneezing; Sighing; Yawning;*
- *Hiccough; Laughing; Crying; Sobbing.*

Voice:

- *The Organ of Voice*—Larynx, Thyroid, Cricoid, and Arytenoid Cartilages—Vocal Cords;
- *The Production of Voice*—Loudness, Pitch, and Quality of Voice;
- *Speech*—Vowel and consonantal Sounds.

The lungs are the organs of respiration, that is, of breathing. Everyone knows that the continuance of the acts of breathing is necessary to life, and that if respiration be suspended, as it is in choking, strangling, drowning, &c., for even a few minutes, death results. The vast importance of this bodily function, and the great and constant danger of any disease that seriously

interferes with its due performance, will be fully appreciated if a general statement of the position it holds in the processes of life be here given by way of introduction to this section.

At the beginning of last section it is stated that a particular order has been followed in the consideration of the various organs of the body, so that any one who chooses to read the first division of each section, one after another in their order, may have a general idea of the whole living human machine. It is there (at p. 212) pointed out that Section VI. (A) discusses the means by which food is prepared to form part of a nourishing fluid—the blood, and that Section VII. (A) describes other sources of blood-forming material. Section VIII. (A) follows out the same line by describing the nature of the blood and the means by which it is distributed throughout the body. It points out also (p. 217) that the purpose of the blood is to nourish each minutest element of the body, to give to it raw material for its use in growth and activity, and that it not only gives up to tissues something to maintain them, but acts as a means of carrying away from them the products of their activity, waste substances which, if allowed to remain, would impair their health and vigour, and that thus the blood becomes impoverished as much by poisonous materials added to it as by nourishing materials taken from it. Now, as already said, between Section VI. and Section VII., the sources of new nourishment to the blood have all been exhausted, with one exception, that of oxygen gas; but none of the means, by which poisonous waste matters cast into the blood are removed, has yet been considered. The lungs supply the oxygen, and on this ground must be considered as organs of blood formation. But at the same time that they supply oxygen, and by the same method, they remove from the blood carbonic acid gas, and that gas is one of the principal waste substances. On this ground, therefore, they rank as blood purifiers. If, then, the lungs are seriously interfered with, a twofold blow is dealt at the blood—the very stream of life—for the risk at once arises of its supply of oxygen being diminished, without which it is unable to nourish the tissues; and the risk also arises of the carbonic acid being allowed to remain, whose presence renders it poisonous to the tissues. With the consideration of the lungs, then, we complete our view of the sources of supply to the blood, and begin our view of the means of its purification.

The Apparatus of Breathing.

The Windpipe or Trachea.—The lungs may for the moment be regarded as sacs situated in the chest, which communicate with the outside by means of a series of tubes. The chief of these is the trachea or windpipe, which passes down the front of the neck into the chest. It is about 4½ inches long. It is surmounted by the **larynx** (*the box of the windpipe*), a box-like structure made of cartilage (gristle), which contains the organ of voice, to be described later in this section. The larynx may be felt projecting at the upper part of the neck, and in some people it visibly projects. The projection is called the **pomum Adami, Adam's apple.** The upper end of the larynx opens into the pharynx or throat, and is provided with a lid—the **epiglottis**—which closes the opening under certain circumstances. The parts will be understood by referring to the accompanying figure, which represents the larynx and the windpipe. L is the larynx, formed mainly of two pieces of cartilage, called the **thyroid** (*Th.*) and the **cricoid** (*Cr.*). A little below *Cr.* the larynx passes into the windpipe. *e* of the figure points to the tongue-shaped epiglottis, shown raised, but when lowered capable of covering over the upper opening of the windpipe. Now let the reader refer to Fig. 88, p. 136, and the relation of these to surrounding parts will be understood. On that figure *ep* points to the epiglottis; the line pointing to *g* is a little below the level where the larynx passes into the windpipe (*w*). It will be seen also that the larynx opens into the back of the throat, the opening being guarded by the epiglottis, and that the gullet (*g*) is just behind the windpipe. Further, it will be seen that the finger, placed on the skin where the turn is made from under the chin on to the front of the

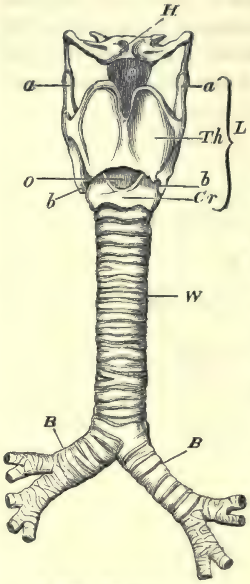


Fig. 129.—The Larynx and Windpipe.

L, larynx, formed of *Th.* and *Cr.*, thyroid and cricoid cartilages. *a*, *a*, *b*, *b*, processes or horns of thyroid (see p. 262). H, hyoid bone. *e*, epiglottis. W, windpipe. B, B, bronchial tubes.

neck, will touch the upper edge of the larynx, and that this is below the root of the tongue. Before air can enter the trachea, then, it must pass through the mouth or nostrils (still refer to Fig. 88) into the pharynx (*ph*), past the raised epiglottis, through the larynx, and so into the trachea. Now it will at once occur to any one that if air can enter into the larynx or windpipe, so can water, or anything one may be drinking, or for that matter anything one may be eating. This accounts for food or drink, or things being held in the mouth, a coin, &c., slipping accidentally into the windpipe. But why does this happen only accidentally? Why is it not a constant occurrence? Let any one put his finger on the front of the neck, on the notch at the top of the larynx, and then let him swallow. He will feel the larynx suddenly lifted up, and when the swallowing is over drop down again. By this action the larynx is raised up to be under cover of the root of the tongue, and at the same time the epiglottis folds down. These movements are effected by nervous action, and it is only accidentally, when the parts are taken unawares, as it were, that anything can drop into the larynx or windpipe. The position of the gullet behind the windpipe explains how a mass of food that has been swallowed, and has stuck in the gullet, by pressing on the windpipe in front produces the sensation of choking, though there is no difficulty in breathing.

The Bronchial Tubes.—The lower end of the windpipe is situated in the chest, and there it divides into two branches (Fig. 129), one of which passes to each lung. Each branch is called a **bronchus** (Latin *bronchus*, a windpipe), and is called right or left as it passes to the right or left lung. The place where the tube enters the lung is called the root of the lung. Each bronchus after passing into the lung divides into smaller tubes, and these again into still smaller, and so the division and subdivision go on till the whole lung is penetrated by branches, the final subdivisions of which are of extreme fineness. To all these divisions and subdivisions the general term **bronchial tubes** is applied. The smallest of them are only about the $\frac{1}{50}$th of an inch in diameter. Fig. 130 represents A, the windpipe, branching into B, the left, and C, the right bronchus, and these into smaller bronchial tubes, such as D. This figure is, however, only a representation, for the multitude of tubes of extreme fineness into which the larger tubes ultimately break up cannot, of course, be shown, though some attempt is made to represent them on the side on which B is placed.

Now there are some remarkable features worth pointing out in the structure of the windpipe and bronchial tubes. Unless some provision was made to the contrary the tubes, even

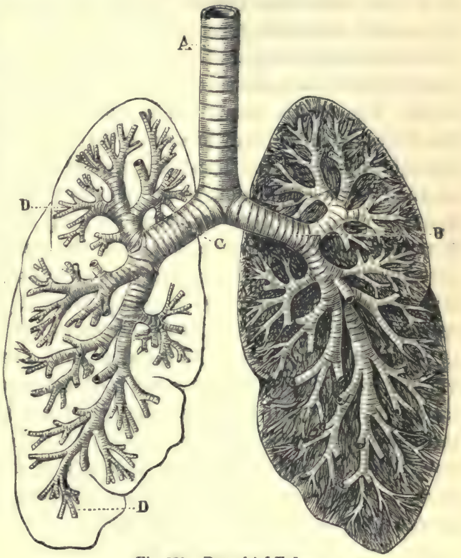


Fig. 130.—Bronchial Tubes.

the largest of them, would readily collapse, their walls would fall together with the slightest pressure, and the fair-way for the passage of air would be closed. The walls are, however, stiffened by pieces of cartilage (gristle). In the windpipe the pieces of cartilage are C-shaped, the deficient part being behind resting on the gullet. In Fig. 129, W points to one of the cartilaginous rings, and in Fig. 135 (p. 262) is seen how they terminate behind. In the bronchial tubes plates of cartilage are disposed in the circumference of the walls, and act like the rings of the windpipe, keeping the tubes open. In the smallest tubes, however, the cartilage is absent, and the tubes become liable to spasmodic closure. In the windpipe the defective portion of the rings behind is closed by a band of muscular fibres of the involuntary kind (p. 70), while in the bronchial tubes there is a middle coat formed of a continuous layer of involuntary muscular fibres dispersed round the walls. Both windpipe and bronchial tubes have elastic fibres running the length of the tubes. The inner surface is lined by mucous membrane continuous through the larynx with that of the throat, mouth, and nostrils. An inflammation attacking the throat is thus apt to travel along the membrane downwards into the windpipe and bronchial tubes,

leading to cough, and perhaps to bronchitis. This mucous membrane is covered by layers of epithelial cells, those on the surface being provided with the hair-like processes called cilia, depicted in Fig. 5, p. 16. The mucous membrane is provided with glands, which, by their secretion, keep the membrane moist. These anatomical details are interesting because of the purposes which the structures are fitted to serve. As already pointed out, the cartilage keeps the tubes open. The elastic tissue confers elasticity on the tubes, permits them to stretch readily with the movements of the neck, &c., and to return to their usual condition when the stretching is over. The cilia of the epithelium keep up a constant waving movement, all in the same direction, namely, upwards, and thus any excessive secretion or defluxion is gently urged upwards to the top of the windpipe, from which it is expelled by a cough. Material is thus prevented from passing downwards and accumulating in the small tubes, so that they are in ordinary circumstances kept clear. It is believed that the muscular layer, specially of the smaller tubes, acts in a similar way, sweeping upwards by its contractions matter to be expelled. An eminent physician has, on this account, called them "scavenger muscles." It may be mentioned here that this muscular coat, in unhealthy conditions, may by its excessive contraction produce a serious difficulty in breathing. If muscular spasm occurs in the smallest tubes, unprovided with cartilage, it may close the tubes, prevent the passage of air, and so occasion severe difficulty of breathing. This spasm would be produced among other things by excessive nervous action, and is believed to be the cause of the difficulty of breathing in nervous asthma. But, again, it should be noticed that if one attempted to breathe an irritating gas the muscular coat would be stimulated to contract, would bar the way to the entrance of the hurtful gas, and so be of great benefit.

It has been noted that the smallest bronchial tubes have no plates of gristle in their walls. They lose also the hair-like processes of the epithelial cells, which are reduced to one fine layer.

The Lungs.—In an earlier paragraph of this section the lungs were, for the moment, represented by two bags or sacs communicating by means of tubes with the external air. This would almost be a proper description of the lungs of some of the lower animals, if we add to it that the sacs have depressions in the inner surface of their walls resembling the cells of a honey-comb. In the lungs of the higher animals and of man the structure is much more complicated, although built up, so to speak, on the type of the elementary structure just noticed. If one of the smallest bronchial tubes be traced to its extremity it is found that it leads into a passage wider than itself, and that from that passage there open out on all sides honeycomb-like cells. This is represented in outline in I of Fig. 131, where *b* indicates the termination of the bronchial tube, *h h h* the passage into which it leads, and *c c c* the cells opening off the passage. The cells are called **air-cells** or

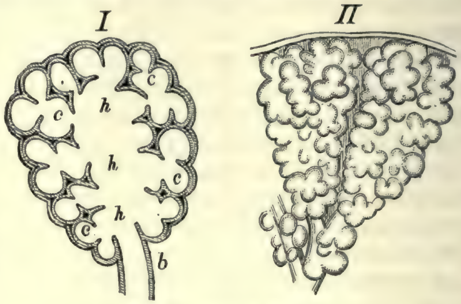


Fig. 131.—Air-cells of the Lung.

alveoli (Latin *alveolus*, a small cavity), and the passage is the **alveolar passage.** The whole arrangement of passage and air-cells springing from the termination of a bronchial tube is called an **infundibulum**, because of its widening out from the place where it arises from the bronchial tube. It is also called an ultimate lobule. II of Fig. 131 shows two such infundibula from the lungs of a newly born child (magnified twenty times) as they appear when not opened up, as they are in I. Now each such ultimate lobule of a human lung is a very small miniature of the whole lung of some of the lower animals. So that a whole human lung is a kind of assemblage of miniature lungs of the type of the lower forms. For several infundibula are grouped or packed together, and thus form a lobule, larger than the ultimate lobule, from a quarter to half an inch in diameter, and bound by connective tissue. Several lobules are bound together in a similar way to form a lobe of the lung. The right lung has three such lobes, and the left two.

The walls of the air-cells are very thin, consisting of delicate elastic and connective tissue, and lined inside by flat transparent cells. In the connective tissue run capillary vessels belonging to the pulmonary artery and veins (p. 223). Now if Fig. 131, I, is attentively considered it will be seen that these hair-like vessels run-

ning in the connective tissue are surrounded on all sides by air-cells, so that the blood flowing through them is only separated by the thin walls of the vessels, and by the delicate tissue of the air-cells from the air which these cells contain. The deep significance of this will be apparent immediately. It need only be noted now that such an arrangement is perfectly adapted for exchanges taking place between the blood in the capillaries and the air in the air-cells.

Each lung is surrounded by an investing membrane—the **pleura**. Like the investing membrane of the heart (p. 219) the pleura of each lung is in a double layer. One layer closely envelops the lung and at the root of the lung is folded back on to the wall of the chest cavity, of its own side, which it lines. The two layers thus form between them a shut sac, a serous cavity. No cavity exists, however, in health, but the two layers glide on one another, and the inner surface secretes a slight amount of serous fluid to prevent friction. It is inflammation of this membrane that is called pleurisy (p. 267).

Through the root of the lung vessels pass to and from the lung. The pulmonary artery enters carrying blood from the right side of the heart to the capillaries of the air-cells, to be purified by contact with the air the cells contain. The pulmonary veins leave the lung by the root to pass to the left side of the heart, carrying the purified blood. Branches from the great artery—the aorta—called **bronchial arteries**, enter the lungs at the root carrying pure blood to be distributed over the bronchial tubes and among the connective tissue of the lungs, to maintain their nourishment. Lymphatic vessels also pass out by the root to join the thoracic duct (p. 202). For lymphatic channels are distributed through the lungs over the bronchial tubes, and are in direct communication with the air-cells. It is by means of the lymphatic vessels that matters are absorbed from the lungs, and afterwards may be poured into the current of the circulation, after passing through glands.

The lungs are also supplied with nerves.

The position of the lungs is shown in Fig. 116 (p. 219). One lung occupies the right side, the other the left. They meet in the middle line, but the lung of the right side reaches farther down in the middle line than that of the left, because a deep notch exists in the front border of the left into which the heart projects. When both lungs are well filled with air the heart is covered except the portion in the position of this notch. As seen in the figure (116) a line drawn downwards and to the side to the level of the tenth rib, from about the position where the sixth rib joins the breast-bone, will indicate the extent to which the lungs reach downwards. On the left side, however, the lung extends downwards farther than on the right side by the breadth of a rib. On each side the lungs reach upwards higher than the first rib, the top of each lung passing up into the neck on each side for an inch and a half above the level of the first rib.

The Diaphragm.—The base of the lungs rests on the muscular partition—the **diaphragm**—which separates the cavity of the chest from that of the belly. This muscular partition is one of the main agents in the act of breathing, and its position must be understood. It forms the floor of the chest cavity and the roof of the abdominal cavity, just as the roof of one room is the floor of the room above it, and separates the two from one another. It is not flat, however, but arched, the arch being directed upwards. This will be understood by a reference to Fig. 132, which is a section of the body carried from back to front, and shows the cavities of chest and belly, with their contents removed. The diaphragm is also shown in section, arching from B in front. It is seen that it is convex towards the chest and concave towards the belly. It is attached all round to the breast-bone and ribs in front, to the ribs at the side, and to the ribs and back-bone behind, being attached lower down at the sides and back than in front. On its upper surface the base of the lungs rests, the pleuræ being connected with it and the investing membrane of the heart also. This is well shown in Fig. 91 (p. 138), where C points to the diaphragm. It also shows that immediately below the diaphragm and mainly on the right side the liver is situated, while mainly to the

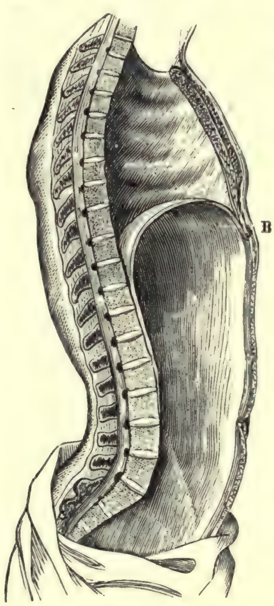


Fig. 132.—The Diaphragm.

left side is the stomach. If the liver be gorged with blood—congested—or the stomach distended with wind, pressure will be exerted upwards, will force up the diaphragm, will prevent the proper filling of the lungs with air, by diminishing the space for their distension, and so will occasion breathlessness. Now the diaphragm, being partly composed of muscle, is capable of contraction. When it contracts, the sides being fixed by their attachments to the ribs, &c., its centre will be pulled on and, therefore, lowered. That is to say, the floor of the chest will be lowered, the cavity of the chest will thereby be enlarged, and room will be afforded for the expansion of the lungs. On the other hand, when the diaphragm becomes relaxed, its contraction being over, it will rise by its own elasticity, the cavity of the chest will be diminished, and air will be forced out of the lungs to afford room for the rise. As we shall see, it is chiefly by the regular succession of contraction and relaxation of this muscular partition that the movements of breathing are carried on.

The Movements of Breathing.

If a healthy person be observed it will be noticed that the act of respiration or breathing consists of a regular series of movements. With the taking in of breath the chest rises and the belly is slightly pushed outwards. That is immediately followed by the falling of the chest, the return of the belly to its former size, and the output of air. Succeeding this is a pause, and the same set of movements is thereafter repeated. The first act is called **inspiration** (Latin *in*, in, and *spiro*, I breathe), and the second is expiration (Latin *ex*, out, and *spiro*, I breathe). What is, therefore, called the **rhythm of respiration** consists of three parts, inspiration, expiration, pause, one after the other in regular order, the three parts forming one respiration. In an adult healthy man the number of respirations should be about 16 per minute, but the number varies with age, that of a newly born child being 44 (see p. 11). During the time of one respiration there should be about 4 beats of the heart. Besides age other things affect the number of respirations per minute. Exercise increases the number, while rest diminishes it. The number is smallest during sleep. Mental emotion and excitement quicken the rate; the mere paying attention to one's own breathing affects the rate. Of greatest consequence is the effect of disease. In fevers the rate is increased and the rapidity of the pulse is increased in proportion. In diseases specially affecting the lungs, such as bronchitis, pleurisy, consumption, &c., the rate of breathing is very marked, and usually where the lungs specially are involved, the increased rate of the breathing is out of all proportion to the increased rapidity of the heart. In such diseases there may be as many as 60 or 70 respirations per minute.

The cause of the respiratory movements may be made plain by a simple experiment. Let a glass bell-jar with a neck and open mouth be taken (Fig. 133). Let two small india-rubber bags (*b b*) be connected to the end of a glass tube (*c c*), and let them be introduced into the jar, the glass tube passing through a tightly-fitting india-rubber cork. Then let a leather floor (*e*) be fixed to the jar, shaped as shown in Fig. 133, so that it may be pushed up into the jar into the position marked *e*, or pulled down into the position marked *d*. The floor must also be air-tight. Now here we have a chamber (*ch.*) entirely shut off from the outside air, and hanging in it are two bags, whose cavities have no connection with that of *ch.*, but communicate with the outside air by the tube *c c*. The air in the chamber and the air in the bags are both under the same pressure, that of the atmosphere, a little more than 14 lbs. to the square inch. Now suppose the leather floor to be in the position of *e*, let it be caught by the hand and pulled down to the position of *d*. By this movement the cavity of the chamber is increased in size, and, as it has no communication with the outside, no air can enter to occupy the increased space, and consequently the air already present expands to fill the larger cavity, that is, it becomes rarefied. The result is that the pressure of air in the interior of the chamber is less than it was before. But the pressure of air in the inside of the elastic bags (*b b*) is undiminished, so that the pressure within them is greater than the pressure outside of them, that is, in *ch.* In consequence the bags yield to the pressure of air within them, they expand, air entering by the tube *c c*, and they continue to expand until their increased size (shown by the dotted lines *f f*) makes up for the addition to the size of *ch.*, until they occupy the increased space. Next let the leather floor be pushed up, the size

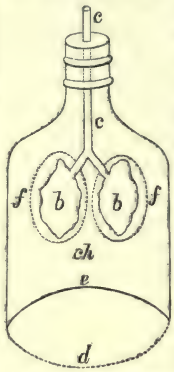


Fig. 133.—The Mechanism of Respiration.

of *ch.* is diminished, the bags are pressed on from within, air is expelled from them, so that they become smaller, and the original state of affairs is restored. Now this is precisely what takes place in the chest and lungs. Let us compare the two things step by step. The chest is a chamber, formed of bony walls, the ribs, connected in front with the breast-bone and behind with the back-bone (see Fig. 17, p. 21). The spaces between the ribs are occupied by muscles —the **intercostal muscles** (Latin *inter*, between, and *costa*, a rib), while large masses of muscle clothe the chest in front and behind, layers of fat and connective tissue covering them, and the skin being outside of all. The chest has for its movable floor the diaphragm already described. It is an air-tight chamber comparable in every respect to *ch.* of Fig. 133, with this additional advantage, that its walls are movable as well as its floor. It has suspended in it the lungs, whose air-cells communicate with the outside by means of the bronchial tubes and windpipe, but have no connection with the general chest cavity, and which are accurately represented by the elastic bags (*b b*). This much, however, must be noticed, that the lungs and other contents of the chest completely fill its cavity, and do not simply occupy a small space in it. The contraction of the muscular fibres of the diaphragm causes it to descend, and thus increases the size of the chest cavity. The pressure of air in the lungs is thus made to exceed that in the chest, a quantity of air, consequently, enters the lungs, which expand to fill up the increased space, just as pulling down the leather bottom of *ch.* causes the elastic bags to distend. As soon as the contraction of the diaphragm is over, it relaxes, returns to its original position, reduces the size of the chest cavity, and air is expelled from the lungs to permit them to diminish in size. After a short pause the diaphragm again descends by contraction of its muscular fibres, and the round of operations is repeated.

The cavity of the chest is enlarged from above downwards by the descent of the diaphragm, but this is not all. Its walls are also movable. The ribs may be raised by the contraction of the intercostal and other muscles, and by their rising they push forward the breast-bone. The chest cavity is by this means enlarged from side to side and from before backwards. Thus the cavity of the chest is increased in three directions, from above downwards, from side to side, and from before backwards, by the descent of the diaphragm and by the elevation of the ribs. As a result the expansion of the lungs is made more vigorous. This is the cause of the breathing in of air, of *inspiration*, which is seen to be essentially *a muscular act*—the result, that is to say, of a series of muscular contractions. But as soon as the contraction is over, the ribs tend, by their weight, to fall down into their position of rest, the muscles tend to relax, and the lung tissue, which is elastic and has been stretched by the expansion, tends to return to its original unstretched condition, as an elastic band which has been stretched recovers itself as soon as the stretching force is removed. The result is, the original size of the chest cavity is restored, and a quantity of air is expelled from the lungs. So *expiration* is seen to be essentially the result of an *elastic recoil*, and not active muscular contraction. While this is the mechanism of *ordinary quiet breathing*, other forces are brought into play when breathing is difficult, as when the windpipe or bronchial tubes are obstructed, notably as in asthma, where there is spasmodic closure of the bronchial tubes, and in diseased conditions of the lungs, which create an obstacle to their expansion. In such cases many additional muscles are called into play, which contract vigorously for the purpose of pulling up the ribs more completely and compelling the lungs to expand, producing what is called **forced inspiration**. Thus asthmatic people, who are awakened out of sleep by a spasm, instinctively raise their arms to grasp something above the level of the head. This is for the purpose of obtaining a fixed point of support from which muscles, passing from the arms and shoulders to the chest, may act in forcibly raising the ribs. Again, when the output of air is hindered, **forced expiration** results. Breathing out ceases to be the result of a mere elastic recoil, and muscles are called into play, such as those passing up from behind to the lower ribs, whose contraction pulls down the ribs, and those of the abdominal walls, whose contraction presses on the contents of the belly and forces them up against the lower surface of the diaphragm, causing it to ascend.

Varieties of Breathing.—The two main agents in the production of breathing being the descent of the diaphragm and the elevation of the ribs, the movements visible from the outside vary according to the predominance of one or the other.

In men and in children the action of the diaphragm is marked. Its descent diminishes the

space in the cavity of the belly, presses on the organs therein contained, and causes an outward movement of the belly walls, so that the movements of its walls are specially noticeable. This is called **abdominal or diaphragmatic** breathing.

In women the action of the ribs is more strongly marked, and the chest rises and falls more than in men. This is **costal** (*costa*, a rib) breathing.

Abdominal breathing is well seen in infants. It ought, therefore, to be plain how the common practice of binding children tightly round the belly is extremely injurious, since it interferes with the natural performance of the respiratory act.

These natural varieties of breathing are altered in various ways by disease. A painful disease of the belly will compel a man to prevent movement of the abdominal walls as much as possible, and then the costal variety will take its place, while some disease of the chest will often cause a woman to suspend her natural method of breathing, and to adopt the abdominal form. In this way one is sometimes able to form an idea of the seat of a disease simply by watching the movements of respiration, and observing whether they are of the kind that would be expected in ordinary states of health.

Facial breathing is the term applied to the movements of the nostrils, seen particularly well when breathing is laboured. It consists in an expansion of the nostrils with each inspiration, and a return to their previous condition in expiration. In children with bronchitis, or inflammation of the lungs, it is marked. Indeed whenever it is specially noticeable, unless after considerable exertion, it should call attention to the condition of the lungs.

The result of the movements of respiration is alternately to introduce and to expel from the lungs a certain quantity of air. When a man breathes quietly, 30 cubic inches of air enter the lungs with each inspiration, and 30 cubic inches pass out with each expiration. After taking an ordinary breath a man may, by forced inspiration, by taking the deepest possible breath, introduce into his lungs an additional 100 cubic inches. Again, after breathing out an ordinary breath (30 cubic inches) one may by an effort expel 100 cubic inches more. But even after the utmost expulsive effort 100 cubic inches remain in the lungs which cannot be expelled. The 30 cubic inches that pass in and out in quiet breathing form what is called the **tidal air.** The 100 extra cubic inches one may draw in with effort are the **complemental air,** and the 100 extra cubic inches one may expel with effort after breathing out the ordinary amount form the **supplemental air.** The 100 cubic inches which remain and cannot be expelled form the **residual air.** Thus the lungs of an adult man are capable of containing altogether 330 cubic inches of air, thus composed:—

Complemental air	100	cubic	inches.
Tidal ,,	 30	,,	,,
Supplemental ,,	100	,,	,,
Residual ,,	100	,,	,,
	330		

If, then, a person, after taking the deepest possible breath, proceeds to breathe out as much as he can, he expels—

Of complemental air	100	cubic	inches.
,, tidal ,,	 30	,,	,,
,, supplemental ,,	100	,,	,,

Making a total of 230 cubic inches, forming what is termed the **vital capacity** of the chest, after which there remain in the lungs the 100 cubic inches of residual air. The vital capacity is then determined by the amount of air a person can expel with the utmost effort after taking the deepest possible breath, and ought in a healthy adult man of average height and weight to equal 230 cubic inches. In women it is less than in men. There are various forms of instruments for measuring the amount. They are called **spirometers,** or measurers of breathing, and are some form of what is familiar to everyone under the name gasometer. The vital capacity varies with height and weight, increasing with increasing height above the average, and slightly decreasing with increased weight above the average.

The Nervous Control of Breathing.—The movements of breathing go on without the necessity of any interference on our part, without our consciousness of them being necessary. During sleep their regularity is even greater than when we are awake, and when awake we may alter the movements to some extent, but cannot altogether arrest them. The breath may be held for a time, but speedily the need for breath gets the mastery, and a long deep breath is drawn. Now it has been shown that there is a particular part of the nervous system that presides over the respiratory function. It is situated in the medulla oblongata (p. 93). Destruction of this part is followed by immediate stoppage of breath-

ing and death. On this account this region of the medulla has been called the *vital knot* (*nœud vital*). Here there is, that is to say, a nervous centre for breathing. It is injury to this centre that proves fatal in cases of broken neck. From it regular discharges of nervous activity pass outwards to the nerves that supply the diaphragm and other muscles of respiration, and stimulate them to the regular or periodical contraction which, as we have seen, is the cause of the movements of the chest, the expansion of the lungs, and the entrance of the air. But the centre is capable of being influenced in various ways. Chiefly it is affected by the condition of the blood. When the blood becomes more venous the action of the centre is excited, and more vigorous respiratory movements occur. On the other hand, if a series of very deep breaths is taken, so that the blood becomes more richly supplied with oxygen than usual, a considerable time will elapse before the need of another breath is felt, and after the interval the breathing will be resumed, the first inspiration being feeble, and those succeeding gradually increasing up to the average. The meaning of this is that the presence of the unusual quantity of oxygen in the blood has calmed the respiratory centre, so that for a time it has ceased its regular periodical discharge, till, as the blood begins to become venous, the usual stimulus is restored. This explains how persons may train themselves to remain under water for some time with no arrangements for permitting breathing to go on. They take a series of deep inspirations, take into the blood, as it were, a stock of oxygen sufficient to last for a little time, and before they dive under the surface. The respiratory centre is, then, stimulated by the presence of excess of carbonic acid in the blood, and soothed by the presence of excess of oxygen. It is the great excess of carbonic acid present in the blood, in cases of continued obstruction to the breathing, that produces the excessive stimulation of the centre, indicated by laboured breathing and the convulsions of suffocation. The centre may, however, be stimulated in other ways. Nerves of sensation supplying the general surface of the body are capable of conveying influences to it leading to its excitement, and ending in vigorous respiratory movements. Thus cold water dashed on the face or chest, a sudden draught of cold air on an exposed part of the body, &c., are speedily followed by a deep, long-drawn breath. The cold water or air has irritated sensory nerves, and the stimulus has been conveyed to the centre, producing a discharge of nerve force to the muscles of inspiration. This fact is of common application in cases of fainting; and newly-born children, who show some delay in beginning to breathe, are roused to the performance of this function by rapid rubbing of the sides with the fingers, by dashing a small quantity of water on the bare chest, or by blowing on the face, all of these methods exciting sensory nerves. The action of the respiratory centre may also be modified by influences from above—from the brain—by mental emotions, for example. One nerve in particular conveys impressions to the centre for respiration, affecting through it the movements of breathing. It is the **pneumo-gastric** or **vagus** nerve (p. 96). Some fibres of that nerve end in the lungs, and thus from the lungs themselves, in some way not yet understood, influences pass upwards to the centre in the medulla oblongata which affect the respirations. By means of that nerve the centre is kept informed, as it were, of the conditions of the lungs themselves.

Even as the oxygen and carbonic acid gas in the blood directly act on the centre, so drugs that have been taken and have passed into the circulation may act on it. Notably does morphia influence it, markedly reducing its activity. In morphia poisoning it is maintenance of breathing that must chiefly be attended to.

The Purpose of Breathing.

We must now try to understand what is the object of the remarkable and complicated structure of the lungs and of the movements which have been described.

The Gases of the Blood.—On p. 217 it has been shown that the blood contains three gases, oxygen, carbonic acid gas, and nitrogen, partly dissolved in it, partly in chemical union with certain of its constituents. The nitrogen need not be taken into account. The oxygen is to be considered as part of its nourishing material which the tissues, to which the blood is distributed, require to carry on their processes. The carbonic acid gas is a waste substance which the tissues produce by their activity, and which the blood carries away from them. As the blood flows through the body its oxygen is removed from it, carbonic acid gas being substituted; and if the efficiency of the blood to nourish the tissues, in this respect, is to be maintained, it must always be receiving new supplies of oxygen, and a means must be at hand of ridding it of its excess of carbonic acid gas. This double

function it is the business of the respiratory process to perform. The blood that is sent out from the left side of the heart on its mission to supply the body is of a bright scarlet hue (the colour of arterial blood), while the blood that returns to the right side of the heart, after its mission is accomplished, is of a dark purple colour (the colour of venous blood). This change in colour takes place in the capillaries, the vessels whose walls are so delicate as to permit of free interchange between the blood in the vessels and the tissues outside of them. In short, it is due to the fact that in the capillaries the blood gives up its oxygen to the tissues, and receives from them carbonic acid gas. This is proved by chemical analysis, which shows that arterial blood contains more oxygen and less carbonic acid than venous blood,[1] and by the experimental fact that if the dark-coloured venous blood be shaken up with oxygen it becomes of a scarlet colour, while arterial blood shaken up with carbonic acid gas becomes purple. Now, as mentioned on p. 223, the venous blood, returned from the body, is conveyed to the right side of the heart, and thence by the pulmonary artery to the lungs, through which it is distributed in capillary blood-vessels to be gathered up into the pulmonary veins and carried to the left side of the heart. But when it leaves the right side of the heart the blood is purple-coloured, and when it enters the left side it is scarlet. That is to say, while passing through the capillaries of the lungs it has been converted from venous into arterial blood. In other words, in its progress through the lungs it has given off its excess of carbonic acid gas and obtained a new supply of oxygen. So that while in the general capillaries of the body the blood is rendered impure by being deprived of much of its oxygen and being laden with carbonic acid, in the capillaries of the lungs the process is reversed, and the blood is purified by being rid of its excess of carbonic acid and by having its proper quantity of oxygen restored. Now it has been already stated (p. 252) that the capillaries of the pulmonary artery, through which the blood flows on its way from the right to the left side of the heart, are distributed over the walls of the air-cells of the lung, and that the air-cells are so numerous and closely packed, and their walls, as well as those of the capillaries, so thin that there is no obstacle to an interchange taking place between the blood in the vessels and the air in the air-cells. It is manifestly here, then, that the change occurs which transforms the dark-coloured, carbonic acid laden venous blood into the bright-hued blood refreshed with oxygen. How does that conversion occur is the next question.

Exchanges between the Blood and the Air in the lungs. It is a well-known physical law that if two different liquids be placed in a vessel in contact with one another and be left alone, without any disturbance whatever, they do not remain separate, but proceed straightway to mix, and in time there will be a perfect mingling of the two liquids. Suppose, for example, that water and spirit are taken, and, for the sake of seeing the experiment going forward, that the spirit is coloured red, that the water is placed in a glass jar, and when it is perfectly still that the spirit is carefully poured on the top of it, so carefully that the two layers, one below of colourless water and the other above of coloured spirit, are quite distinct from one another. If the jar be set aside, it will be observed that the coloured spirit does not long remain all on the top, though it is lighter than water, but that the colour gradually passes downwards into the water, until in time the whole is coloured—an equal mixture of water and spirit is found in the jar. This is called **diffusion of liquids.** Now the same thing occurs with gases though the process is not visible. If one glass jar be filled with carbonic acid gas and a second with oxygen gas, and if the jar containing the oxygen be placed upside down on the top of the jar containing the carbonic acid, the jars being fitted mouth to mouth, then we have practically one glass vessel, composed of two jars united at their mouths, the lower part containing carbonic acid gas and the upper oxygen, the two being in contact with one another. In spite of the fact that the lower gas is much heavier than the upper one, the two proceed to diffuse, the heavy one passing up into the light, and the light one passing down into the heavy. In course of time, and the time is not long, the vessel contains a perfect mixture of carbonic acid gas and oxygen. This is **diffusion of gases.** On pp. 134 and 135 it is stated that two liquids will mingle even when separated from one another by a membrane, and similarly two gases will mingle

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[1] This is shown in the following table, in which is stated the quantity of oxygen and of carbonic acid in 100 volumes of arterial blood, and 100 volumes of venous blood:—

	Oxygen.	Carbonic acid.
Arterial blood......	20 volumes.	39 volumes.
Venous ,, ...	8 to 12 ,, ...	46 ,,

The quantity of nitrogen is the same in each, viz. 1 to 2 volumes.

even when separated from one another by a membrane. Thus if a bladder be filled with oxygen, and if, after being firmly closed, it be placed in a jar containing carbonic acid gas, the oxygen will pass through the walls of the membrane to mingle with the carbonic acid, and the carbonic acid gas will pass inwards to mix with oxygen, until the bladder and the jar contain equal mixtures of the two gases. Moreover the process will be aided by the walls of the bladder being moistened with water. This is owing to the fact that liquids dissolve gases. Water exposed to an atmosphere of oxygen will lick up, or, to speak more correctly, will absorb some of the oxygen. It will do the same with other gases; and other liquids also absorb gases, though one liquid will absorb more of one gas than of another. Nay, one liquid, already containing a gas dissolved in it in quantity, is not thereby prevented from absorbing a quantity of another gas. So that, if the walls of the bladder be wet, one side is moistened with water containing oxygen in solution, and the other side is moistened with water containing carbonic acid gas in solution, and an interchange takes place between the two solutions, as described on pp. 134 and 135, so that oxygen passes outwards and carbonic acid gas passes inwards. Not only do liquids dissolve gases naturally, but they may be made by pressure to lick up much more than the usual quantity. As every one knows, a bottle of aerated water contains water charged with carbonic acid gas. The gas is forced into the bottle by great pressure and the water compelled to dissolve it. The pressure is so great that, in order to compel the water to retain the gas, the bottle must be tightly corked and the cork bound down by wire. As soon as the cork is removed, the gas comes off with great force and produces the sparkling or effervescence of the water, while sometimes the pressure of gas in the water is so great as to blow out the cork or burst the bottle. Gas dissolved in a liquid exerts pressure on that liquid in its efforts to escape. If the pressure outside the liquid be less than that of the gas in the liquid, the gas will escape and come off; if the outside pressure be equal to that of the gas in the liquid, or greater, it will remain dissolved. Suppose, then, water containing oxygen in solution be placed in a jar filled with oxygen. If the pressure of gas in the jar be greater than that in the liquid, the water will take up more oxygen, but if it be less it will give off some oxygen, the result being that, in the end, the pressure of gas in the liquid and that outside of it become the same. In the same way if a liquid containing both oxygen and carbonic acid gas be exposed to an atmosphere of mixed oxygen and carbonic acid gas, unless the pressures of the two gases are the same in the liquid and in the atmosphere an exchange will take place. If the pressure of oxygen in the liquid be less than the pressure of that gas in the atmosphere, oxygen will pass into the liquid till both are equal; and if the pressure of carbonic acid gas in the liquid be greater than that outside, carbonic acid gas will pass off from the liquid till both are equal, so that the liquid will gain oxygen and lose carbonic acid gas, while the atmosphere will lose oxygen and gain carbonic acid. The same process will take place even though the liquid be separated from the atmosphere by a membrane, and will occur more readily, as we have seen, if the membrane be moistened on both sides.

Now these facts explain to some extent the changes that occur in the blood in the lungs, for the conditions we have been speaking of are exactly fulfilled. Blood containing oxygen and carbonic acid gas is flowing in a multitude of tiny streams through the walls of the air-cells of the lungs. The air-cells contain a mixture of the same two gases. The blood is separated from the air in the air-cells by a thin membrane, namely, the delicate walls of the capillaries and of the air-cells, and the membrane is kept moist by the blood on the one side and the secretion of the membrane on the other. It has been found that the pressure of oxygen in the blood is less than that in the air-cells, and that the pressure of carbonic acid gas in the blood is greater than the pressure of the same gas in the air-cells. Consequently oxygen passes through the membrane from the air-cells into the blood, and carbonic acid gas passes through the membrane from the blood into the air-cells. The blood thus gains oxygen and loses carbonic acid, while the air-cells lose oxygen and gain the latter gas. At the same time the blood, by having its proper quantity of oxygen restored to it, and its excess of carbonic acid gas removed, changes in colour from purple to scarlet, from venous to arterial blood. It is re-invigorated and purified.

This much must further be noted, that the gases are not simply dissolved in the blood, but are partly in chemical union with it, and this affects to some extent, probably aids, the process.

It will readily occur to any one that the result of this process will speedily be that the air-cells will be largely deprived of their oxygen and will contain chiefly carbonic acid gas. The

pressure of oxygen will soon be even less in the air-cells than it is in the blood, and that of carbonic acid gas greater, so that the process would be reversed, oxygen taken from instead of added to the blood, and carbonic acid gas added to it instead of taken from it. This would make the blood more unfit than ever to nourish the body and more poisonous to it than before. It is evident that if the exchange is to continue of the proper character the air in the air-cells must be constantly renewed, its oxygen restored and its carbonic acid gas removed. How this is accomplished is the next question to consider.

Exchanges between the Outside Air and that of the Air-cells.—The air which we exhale during the act of expiration is very different in character from the external air which we inhale. Both contain principally the same three gases, though in different quantities, as the following table shows:—

	In 100 parts of Air inspired.	In 100 parts of Air expired.
Oxygen,	20·8	15·4
Nitrogen,	79·2	79·3
Carbonic Acid,	·04	4·3

In other words exhaled air contains roughly 5 per cent less oxygen and 5 per cent more carbonic acid than inspired air; the air taken into the lungs loses oxygen and gains carbonic acid. There are also other differences. Expired air is hotter because it has been in contact with the warm air-passages, and it contains more moisture than the external air also from contact with the moist lining membrane of the passages. This is readily observed by breathing on a cold surface, on which the moisture condenses. In expired air there is also a small quantity of animal matters, which gives to the air its stuffy smell.

The quantity of oxygen thus removed from the external air in 24 hours by the breathing of an adult person, as well as the quantities of carbonic acid gas and water given out in the same time, have been carefully estimated. About 18 cubic feet of oxygen are consumed daily by an adult man at rest. The same amount of carbonic acid gas is given out, and would be represented by a piece of pure charcoal weighing 9 ounces avoirdupois. The quantity of carbonic acid, however, varies according to circumstances, increasing up to the age of thirty and then diminishing, being increased also by external cold and by exercise, and being affected by the kind of food taken. The amount of water varies from 6 to 20 ounces daily; on an average it is about half a pint.

The explanation of the difference in the composition of the air inhaled and the air exhaled is simple. During the pause that follows an act of expiration the lungs, that is the bronchial tubes and air-cells of the lungs, are still filled with air. That air, particularly in the air-cells, must be different from fresh air, because the blood is continually drawing oxygen from it and adding carbonic acid to it. When an inspiration occurs the lungs distend, and 30 cubic inches of fresh air enter to fill up the increased space. The new supply occupies only the upper air-passages. An expiration immediately follows the inspiration, but the 30 cubic inches that have previously entered are not expelled. A like quantity is exhaled, but it contains only about one-third of the 30 cubic inches just inhaled. For the supply of fresh air has no sooner entered the lungs than it proceeds to mingle with the air already there, to diffuse into it, and two-thirds of it have already passed down a considerable way towards the air-cells before the expiration, which follows its entrance, occurs. By the process of diffusion the fresh supply passes downwards towards the air-cells, increasing the quantity of oxygen already in the air in the lungs and diluting the carbonic acid. Of the air given out of the lungs in a breath, while one-third is formed of air that has entered just previously to the expiration, the remainder is air from the lungs charged with carbonic acid and deficient in oxygen, which has been displaced by the fresh air. The purpose of breathing is thus apparent: it is to restore to the air in the air-cells of the lungs the quantity of oxygen of which it is being regularly deprived by the blood, and to rid it of the excess of carbonic acid imparted to it by the blood. The two processes that have been now described must keep pace with one another: the process, by which the blood takes oxygen from the air in the air-cells and gives to it carbonic acid, must be counterbalanced by the process by which a certain quantity of fresh air is drawn into the lungs to restore the lost oxygen, and a certain quantity of air is expelled from the lungs to remove the excess of the hurtful gas.

A survey of the ground that has been gone over reveals how the structure of the lungs, the arrangement of the blood-vessels in the walls of the air-cells, and the action of the distension and recoil of the chest and lungs, are all adapted to work together for this one end, namely, to facilitate exchanges of gases between the blood and the air.

Ventilation.

It has been said that if no provision existed for regularly renewing the air in the air-cells, it would become so deficient in oxygen and so charged with carbonic acid gas that the proper exchanges could not take place between it and the blood, which instead of being purified would become more impure. That remark has a wider application. By the process of breathing we remove oxygen from the atmosphere and add to it carbonic acid, so that if the external air is to remain fit for respiratory purposes it must, like the air in the air-cells, be continually renewed. Ventilation is the term applied to the means by which the due renewal of the external air is accomplished in inclosed spaces. Suppose a man were to be shut up for a long time in a confined space into which no fresh air could enter, by and by the air in the space would approach more and more to the character of the air in his lungs, the purification of the blood would cease, and continued life would be impossible. Long before this, however, the impurity of the atmosphere would be revealed, by headache, languor, and oppression. The presence of from 1½ to 3 parts of carbonic acid in every 1000 of our atmosphere is liable to produce headache and giddiness in those breathing it. The problem of ventilation is to remove bad air and supply fresh without causing draughts. In order that sufficient pure air may be present in rooms, &c., in which persons are living, it has been estimated that for each individual there should be a space of, on an average, 1000 cubic feet, and that 2000 cubic feet of pure air per head per hour should be supplied to maintain a proper standard of purity of air in the apartment. It is the excess of carbonic acid whose effects have been chiefly noted. Deficiency of oxygen also causes marked effects, producing difficulty of breathing (dyspnœa) and suffocation (asphyxia), the prominent feature of which is convulsions. These effects are considered under their respective headings in the second division of this section. It is curious that a tolerance for impure air can be established within limits. That is to say, a person may become accustomed to breathe, without any signs of inconvenience, a very impure air which another, coming directly from the fresh air, could not tolerate for a moment.

Artificial Respiration.

We have seen that the entrance of air into the lungs is the direct result of the expansion of the chest. If, therefore, the chest can be expanded artificially air will enter and breathing may be maintained. This can be done even on the dead body. The various methods that may be adopted for restoring suspended breathing are described under ACCIDENTS AND EMERGENCIES.

Altered Respiratory Movements.

Coughing is produced by some irritation specially in the upper part of the windpipe and the larynx. As a result a deep breath is drawn, the opening of the windpipe is closed, and then suddenly burst open by one or several rushes of air, which pass out by the mouth. The object of this is to dislodge and carry away in the rush the material that is the cause of the irritation.

Sneezing is caused by an irritation of the nostrils or eyes, producing results similar to those in coughing, the air, however, escaping by the nostrils. In the beginning of a cold in the head it is the cold air irritating the inflamed lining membrane of the nose that causes the repeated attacks of sneezing. In some forms of inflammation of the eyes the stimulus of light produces sneezing. The eyes are usually kept shut by the sufferer, and the attempt to open them ends frequently in a sneeze.

Sighing consists of a prolonged and slow inspiration, followed by a similar expiration.

Yawning is a very deep inspiration, and is accompanied by movements of the lower jaw, so that the mouth is widely open.

In **hiccough** (p. 182) there is a sudden inspiration, abruptly checked by the closing of the opening of the windpipe (the *glottis*). The sound that it produces is due to the entering air striking against the closed glottis. It is occasioned by irritation of branches of the pneumo-gastric nerve ending in the stomach.

Laughing consists of a series of short spasmodic expirations, succeeding a long breath, the vocal cords, whose movements produce voice, being thrown into activity. It is accompanied by characteristic movements of the face.

Crying is similar, and is associated with different movements of the face.

In **sobbing** there is a series of short convulsive inspirations.

VOICE.

The Organ of Voice or **larynx** forms the upper part of the windpipe. It is constructed of various curiously shaped pieces of cartilage (gristle), connected together by bands of liga-

ment, and is clothed outside by muscles, and inside by a mucous membrane continuous with that of the rest of the air-passages. Fig. 134 shows the larynx and windpipe stripped of muscles. The larynx (L) is seen to be formed of two pieces of cartilage (*Th.* and *Cr.*), one placed above the other. The upper of the two is the **thyroid** cartilage, and the lower the **cricoid** cartilage. The thyroid (Greek *thyreos*, a shield) is formed of two extended wings meeting at the middle line in front in a ridge; above and from the sides two horns project upwards (*a*, *q*), which are connected by bands to the hyoid bone (H), from which the larynx is suspended. The hyoid bone itself is attached by muscle and ligament to the skull. It lies at the root of the tongue, and the finger can feel it at the angle of junction of the chin and neck. From the under surface of the thyroid two horns (*b*, *b*) project downwards to become jointed to the cricoid. The thyroid cartilage thus rests and is movable on the cricoid, movable forwards or backwards, but not from side to side. The cricoid cartilage is shaped like a signet-ring (Greek *krikos*, a ring), the narrow part of the ring being in front. Owing to this narrowness a small space (*o*) is left in front between the two cartilages. The space is closed by membrane. It is through this space that an opening is often made in cases of threatened suffocation owing to some obstruction higher up. The operation is known as **laryngotomy** (cutting the larynx), and is to be distinguished from **tracheotomy**, in which the windpipe is opened. The appearance of the larynx is very different when viewed from behind as in Fig. 135. The thyroid cartilage is not complete behind, while the cricoid is broader than in front. The cricoid carries, perched on its upper edge behind, two other cartilages, of great importance in the production of the voice, the **arytenoid** cartilages (*Ar.* Fig. 135). They are triangular in form as shown in the figure. On their summits are perched small pieces of cartilage, and, when in their natural position, the two form a shape resembling the lip of a ewer, hence their name (Greek *arutaina*, a pitcher).

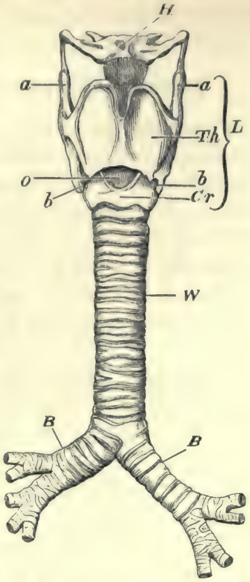

Fig. 134.—The Larynx (L); Windpipe (W); and Bronchial Tubes (B B); e, Epiglottis.

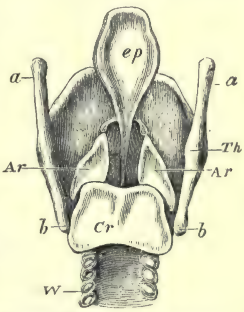

Fig.135.—The Larynx (from behind), the soft parts being removed.

ep, Epiglottis, capable of folding down on the entrance to the larynx like a lid and so closing it. See p. 250. The letters not mentioned in the text apply to the same parts as those of Fig. 134.

Now these various cartilages form a framework on which muscles and mucous membrane are disposed. Thus towards the front one muscle passes from the cricoid up to the thyroid on each side, and when the muscle on each side contracts, the thyroid cartilage is pulled downwards and forwards on the pivot its lower horns form with the cricoid. Another muscle passes from each arytenoid cartilage behind to the thyroid cartilage, and when it contracts it pulls up the thyroid to its original position. Other muscles will be noted immediately.

The mucous membrane, which lines the inside of the box formed of the cartilages described, is thrown into various folds. In particular one fold passes horizontally outwards from each side towards the middle line at the level of the base of the arytenoid cartilages. The free edge of each fold is formed by a band of elastic fibres that passes from each arytenoid cartilage straight forwards to become attached to the thyroid cartilage. These folds are called the **true vocal cords**, by whose movements voice is produced. They are called *true* vocal cords because above them are folds of mucous membrane called the *false* vocal cords, which take no part in the production of voice. The true vocal cords, projecting towards the middle line, encroach upon the space, and reduce the communication between the part of the larynx above them and the part below to a mere chink. This chink is called the **glottis** (from Greek *glotta*, the tongue) or the **chink of the glottis.** Fig. 136 will perhaps render this more easily understood. It represents the larynx, &c., viewed from behind, with all the soft parts in connection with it. On looking down, the folds forming the true cords (*c*) are seen, inclosing a **V**-shaped aperture, the glottis, the narrow part of the space being towards the front. Now by the contraction of various

muscles the form of the aperture may be changed. The vocal cords may be brought so closely together that the space becomes a mere slit. Air forced through the slit will throw the edges of the folds into vibration and a sound will be produced. Variations in the form of the opening will determine variations in the sound. This, briefly, is the mechanism of the production of voice. If all the muscles of the larynx be relaxed the folds do not project nearly so far towards the middle line, the aperture of the glottis is wide, and air may enter and leave the windpipe during the acts of breathing without throwing the cords into vibration so as to produce any sound.

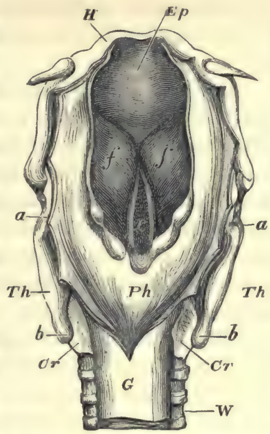

Fig. 136.—View of Larynx from behind with all the soft parts.
f, false cords; *c*, placed in chink of the glottis is between the true vocal cords; Ph, pharynx; G, gullet. The other letters are the same as in Figs. 134 and 135.

The Production of Voice is thus due to arrangements precisely similar to those of some musical instruments. The organ of voice is, indeed, a reed-instrument, the sound produced by the vibrations of the reed or vocal cords being modified by the tubes above and below. All musical sounds are due to movements or vibrations occurring with a certain regularity, and they differ in loudness, in pitch, and in quality. Loudness of the sound depends on the extent of the vibrations, pitch on the rapidity of the vibrations, and quality on the admixture of tones produced by vibrations of varying rates of rapidity related to one another. A tuning-fork vibrating 100 times per second gives out what is called a pure tone. If several other tuning-forks, vibrating at rates which are multiples of 100, say 200, 300, 400, &c., be thrown into vibration, the sounds emitted by them will blend with the sound of the first or **fundamental** tone, and the quality of the sound will be changed though its pitch remains the same. The tones that have been added are called **overtones**. The quality of a musical sound, therefore, depends on the overtones in it. Thus if the same note be produced on a piano, a violin, and a trumpet, the quality of the note of each will be markedly different, though the three notes are of the same pitch, the difference being due to the different overtones present in each. Human voices uttering the same note differ in quality, because the construction of the vocal apparatus of one individual favours the production of a different set of overtones from those of another.

In the production of the voice, then, there are to be noted the arrangements for (1) the vibration of the cords to produce sound, (2) the regulation of the loudness of the sound, (3) the variation of the pitch of the sound, and (4) the determination of the quality of the sound.

(1) In order that the cords may be thrown into proper vibration they must be brought close together and parallel to one another, so that only a narrow slit intervenes between them, through which air is driven with some degree of force. The vocal cords are brought together, so that the space between them is narrowed to a slit, by the action of a muscle which passes from the cricoid cartilage to the outer angle of the arytenoid cartilages. When the muscle of each side contracts the arytenoid cartilages are caused to turn on their bases, so that the vocal cords attached to them are brought close up to one another. Other muscles assist in the manœuvre. This having been accomplished a strong expiration drives the air from the lungs through the slit between the cords, and throws them into movement. Other muscles are connected with the arytenoid cartilages which cause them to rotate in an opposite direction, so separating the vocal cords and widely opening the glottis. By means of an arrangement of mirrors, called the **laryngoscope**, devised in modern times, this operation can be easily seen. A person is seated upright in a chair, a lamp, throwing a strong light, being placed on a table at his side and slightly behind him. In front of him an observer sits, who has a slightly concave mirror fixed on his forehead. The person opens his mouth, and the observer arranges the mirror so as to catch the light from the lamp and reflect it in a bright beam into the person's throat. The observer then takes a small plane mirror, not so large as a shilling, set at an angle on a long stem, and having slightly warmed it, passes it to the back of the person's throat, the person's tongue being pulled gently forwards meanwhile. The observer so places the plane mirror that the light from the mirror on his forehead is thrown on to it, and is then reflected downwards to illuminate the larynx. It requires, of course, some practice and dexterity to arrange the mirrors properly. When it is skilfully done, the observer is able to see in the plane mirror a view

of the illuminated larynx, with its lining membrane and vocal cords. When the person is breathing quietly, the chink of the glottis is seen widely open, but as soon as he utters a sound, as that of *a* in *far*, the cords are seen to advance quickly towards the middle line, so that the passage is completely closed but for the narrow slit between them. A good view of the cords is thus obtained, and they should be pearly white and glistening, with clean-cut edges. The vibration is little in amount, but very rapid.

(2) The extent of movement of the cords will vary with the force of the outgoing current of air, and thus the loudness of the sound will increase with greater force of expiration.

(3) The pitch of sound depends, as we have seen, on the rapidity of the vibrations, and that is determined by two circumstances—the length of the cords and their tightness, for the shorter and tighter a string is the higher the note which its vibration produces. The vocal cords of women are about one-third shorter than those of men, hence the higher pitch of the notes they produce. The cords of tenor singers are also shorter than those of basses and baritones. In children the vocal cords are shorter than in adults. In boys, at the period of puberty, the larynx enlarges. This is accompanied by an elongation of the cords, and a consequent change in the pitch of the voice, which becomes lowered. In popular language the voice is said to *crack*. Thus age and physical growth determine the pitch of the voice. Voluntary variations in pitch are due to the fact that the tension or tightness of the cords can be varied at will by muscular movements. It has been pointed out (p. 262) that the thyroid cartilage can be pulled downwards and forwards over the cricoid by the action of the crico-thyroid muscle. Now the front ends of the vocal cords are attached to the inner surface of the thyroid, and when it is pulled forwards they are stretched, provided the arytenoid cartilages to which their other ends are connected are fixed. The more strongly the thyroid cartilage is pulled on, the higher will be the pitch of the note produced by the vibration of the cords, because the greater will be their degree of tightness. It is believed by some, also, that the vocal cords may be shortened by muscular action causing the cords to overlap one another, so that part of their length is "stopped," and so prevented vibrating. This would also increase pitch, just as a violinist varies the pitch of a note produced by his violin string by "stopping" it at varying distances. It has been suggested that it is such a "stopping" action that determines the production of the falsetto voice.

In opposition to muscles, whose contraction tightens the cords, are others which pull up the thyroid cartilage, and otherwise produce relaxation.

(4) The quality of the voice depends on physical conditions of the cords, their degree of smoothness, elasticity, thickness, &c. Moreover, the form of the windpipe, larynx, throat, mouth, &c., takes part in determining quality. In fact, the air-passages both below and above the vibrating cords act as resonators, or resounding chambers, and intensify and alter the sounds produced by the cords. Indeed, the sounds emitted by the cords would be feeble but for the intensifying action of the air-passages. By their form, however, they are fitted to intensify some notes more than others. The quality of an individual's voice is as much determined, therefore, by the shape and general structure of his throat, mouth, &c., as by his vocal cords. It may be remarked that a knowledge of this fact shows the necessity of the mouth being properly opened during speech, and especially during singing. Each person has the power to alter the shape of his mouth, and so is able to adapt it to a great extent to intensify any particular sound he wishes to utter.

In the ordinary production of voice, therefore, there is a great variety of muscular movement of a very delicate character; how complicated and rapid must be the movements executed by a singer! It is impossible to conceive the delicacy and complexity of the movements voluntarily executed by the well-trained and skilful singer, who adapts vocal cords, larynx, throat, mouth, &c., with speed and precision, so as to produce accurately the desired sounds. The muscular movements involved are all produced in response to nervous stimuli reaching the muscles from the brain.

Various points worthy of notice in connection with the care of the voice will be considered in the second part of this section.

Voice is, then, produced in the larynx, and is altered by the rest of the respiratory passages.

Speech is to be distinguished from voice. It may exist without voice. A whisper is speech without voice. Speech is due to sounds produced by the action of the throat, mouth, and nose. In ordinary talking it is accompanied by vocal sounds. In speech, then, are vowel and consonantal sounds.

Vowel sounds are sounds produced in the

larynx, whose quality is markedly altered by the shape of the resounding chambers above, especially the mouth. Thus, let a person sound a particular note, and utter the vowel sound, *a* (as in *father*), *e* (as *a* in *fate*), *i* (as *ee* in *feet*), *o* (as in *cold*), and *u* (as *oo* in *foot*), and he will find that continuing to sound a note of the same pitch he can produce all the vowel sounds, by alterations in the shape of the mouth principally.

Consonants are sounds produced by interruptions of the outgoing current of air, but in some cases are preceded or followed by vocal sounds. The interruption to the outgoing current may take place by movements of the lips, as in pronouncing *p, b, f, v*. These are **labial** consonants (Latin *labium*, a lip). *M* is also a labial consonant, in which there is a vocal sound suddenly interrupted by a lip movement.

When the tongue, in relation with the teeth or hard palate, obstructs the air, **dental** consonants are produced, *d, t, l, s*. *N* is a dental consonant, a vocal sound being suddenly checked by the tongue and teeth. *S* is also a dental sound, caused by the teeth offering an obstruction to a continuous rush of air past them.

Gutturals are due to the movements of the root of the tongue in connection with the soft palate or pharynx, such as *k, g, ch, gh, r*.

In the production of *ng*, a vowel sound is interrupted by the approach of the root of the tongue to the soft palate. It is thus a guttural sound.

SECTION IX.—THE RESPIRATORY SYSTEM (AIR-TUBES AND LUNGS).

B.—ITS DISEASES AND INJURIES.

The Examination of the Chest:
Inspection; Auscultation; Percussion—The Stethoscope.

Diseases of the Lining Membrane of the Lungs (*Pleura*):
Inflammation of the Lining Membrane—(*Pleurisy*)—Dropsy—Empyæma—Pneumothorax.

Diseases of the Larynx, Windpipe, and Bronchial Tubes:
Inflammation of the Larynx (*Laryngitis*)—Tracheotomy;
Dropsy of the Larynx (*Œdema*)—Scalding of the larynx;
Inflammation of the Windpipe (*Tracheitis*)—Croup;
Inflammation of Bronchial Tubes (*Bronchitis*)—Chronic Bronchitis;
Ulceration of Air-Passages;
Dilatation of Air-Passages (*Bronchiectasis*);
Spasm of the Larynx and Bronchial Tubes—Asthma—Hay-Asthma;
Tumours and Foreign Bodies in the Air-Passages.

Diseases of the Lungs:
Inflammation (*Pneumonia*)—Chronic Pneumonia (*Cirrhosis*);
Congestion—Dropsy—Gangrene and Apoplexy;
Consumption (*Phthisis*) and *Blood-Spitting* (*Hæmorrhage*)—Tubercle;
Dilatation of Air-Cells (*Emphysema*);
Collapse (*Atelectasis*);
Tumours and Cancer;
Injury of the Lungs.

Special Symptoms connected with Affections of the Lungs:
Cough;
Difficulty of Breathing (*Dyspnœa*) and *Suffocation* (*Asphyxia*)—Apnœa;
Lividity (*Cyanosis*).

Affections of Voice and Speech:
Hoarseness;
Clergyman's Sore Throat;
Loss of Voice (*Aphonia*);
The Care of the Voice;
Stammering or Stuttering.

THE EXAMINATION OF THE CHEST.

There are few organs of the body whose condition can be so directly observed by a physician as the lungs, few in the examination of which the physician is so independent of the feelings of the patient. This is due to the adoption, in quite modern times, of methods of

investigation by means of which a physician can, in very many cases, ascertain for himself the condition of a person's lungs without asking him a question. It may be well to note briefly how such an examination is made.

Inspection.—Much information may be gained by simply viewing the chest in a good light, the person sitting upright. Its shape is regarded first of all. In children the shape is circular, in grown-up people the distance from side to side is greater than from front to back. In disease the shape may be altered in various ways: it may bulge at one side, or be drawn in at one side. The "pigeon chest" shows a marked change in shape, the breast-bone being thrust forwards, and the sides flattened. It is the result of such disease as hooping-cough, occurring in childhood, when the bones are soft and readily yield to strain. In rickety children the shape is also greatly altered. Then, often, mere looking at the chest shows it to be flattened in some part. This occurs specially just under the collar-bone, and indicates that, under that place, the lung does not sufficiently expand. Inspecting the chest in this way gives information also about the movements of breathing. Movement increased in one place and lessened in another indicates something unusual. In children particularly an impediment to the free entrance of air into the air-cells is shown by a heaving motion of the belly, accompanied by a sucking in of the lower ribs.

Auscultation is another method. It has been mentioned that the ear applied closely to the chest walls hears sounds of the expanding lungs—a fine rustling noise. If part of a lung be blocked up, no sound will be heard over it. If matter be present in the bronchial tubes, as in bronchitis, the air, as it enters and leaves the lungs, will bubble through it, and give rise to bubbling or gurgling or crackling sounds; or if the tubes be narrowed by inflammation or spasm, whistling or piping sounds will be heard as the air rushes through the narrowed passages. Auscultation may be performed, as stated, by applying the ear directly to the chest, only a soft handkerchief being interposed between ear and skin. It is also performed by means of the **stethoscope**, a tube made of wood, or vulcanite, or metal, having a widened portion at one end for placing on the chest, and a larger expanded part at the other for fitting the ear. The sounds are conducted to the ear by this means. It may be observed that an untrained ear will very readily fail to catch the soft breath sounds of healthy lungs, which the accustomed ear can perceive at once, so that anyone unused to listening over the chest should not conclude that the breath sounds are abolished because he cannot hear them. They are particularly loud in children.

Percussion is a third method of examining the lungs, a method already alluded to as used to determine the extent of the liver and heart (pp. 195 and 239). Everyone knows the hollow sound given out on tapping a cavity filled with air, and the dull, dead sound given out on tapping a solid board. The lungs, consisting of numerous minute cavities filled with air, ought to give out a clear hollow sound when the chest is tapped; but if the air-cells of a lung, or part of it, are blocked up with inflammatory material, if, that is to say, that part has become practically solid, or if a large quantity of fluid has collected in the sac of the lung—the pleural cavity (p. 253)—the dull sound will be produced on tapping the chest over that part. The tapping may be done by the knuckles or tips of the fingers. The best way is to lay a finger of one hand flat on the chest and tap smartly on it with the point of a finger of the other hand. The sounds are thus easily brought out, and the whole surface of the chest may be gone over in this way to see if all parts are equally clear and *resonant*, as it is called. Of course when one taps over the heart the dull sound is produced. The diagram (Fig. 116, p. 219) shows where dulness ought to be usually found, and what extent of the chest ought to yield the clear note of the lungs.

There are various alterations of the sounds heard on auscultation and percussion, produced by disease, which it does not fall within the scope of this work to comment on.

Besides signs of disease of the lungs, thus obtained, there fall, of course, to be added symptoms, ascertained by inquiry of the patient, such as the presence or absence of pain, cough, spit, difficulty of breathing, &c. &c.

DISEASES OF THE LINING MEMBRANE OF THE LUNGS—THE PLEURA.

Pleurisy and Dropsy of the Chest.

Pleurisy (*Pleuritis*) is the name given to inflammation of the serous membrane that incloses each lung as by a sac. The membrane, as described on p. 253, is formed of a double layer, one fold being closely applied over the lung, and the other over the chest wall, a slight

space, in which a small quantity of serous fluid is usually present, being between the two. Now inflammation affecting this membrane is of the same nature as inflammation occurring anywhere else, and its features have been stated on p. 247. The blood-vessels of the membrane, for it is richly supplied with them, are congested, and materials pass out of them into the surrounding tissues, so that the membrane becomes thickened. A considerable quantity of material is poured out on the surfaces of the pleura, and separates into a fibrinous or coagulable portion and a fluid—serous—part. The fibrinous material is deposited on the surface, and the fluid escapes into the small space between the two folds of the membrane. The surfaces of the folds, which are opposed to one another, and ought to glide smoothly on one another with the movements of breathing, are roughened in consequence of the deposit. The movement, instead of being smooth and noiseless, is accompanied by considerable friction, which occasions a fine rubbing sound, that a practised ear can detect by listening with the ear to the chest. If a large quantity of fluid is poured into the space it will separate the two layers of the pleura, and the friction, with its accompanying sound, will cease. Whether much or little fluid accumulates in the pleural sac depends on the nature of the case. In some instances only a few ounces are present, in others the quantity is many pints. So much fluid must make accommodation for itself between the lung and the wall of the chest. It may make some room by forcing out the wall of the chest and making the chest perceptibly fuller on the affected side. But the ribs do not yield very much or readily, and the fluid will make more space by displacing the organs of the chest and crushing the lung together as much as possible. For example, if the pleurisy be on the left side, the heart may be pushed over to the right side by the accumulating serum. The pressure of the fluid on the lung may be sufficient to expel the air from its air-cells, and compress the substance of the lung so that it is squeezed into a compact mass, and the air-cells no longer exist. In some severe cases of this kind the pressure on the lung has been so great that, after death, on the affected side only a small fleshy mass, pushed up into a corner of the chest, remained as evidence of the existence of a lung, the cavity being completely occupied by fluid. **Dropsy of the chest, or hydrothorax** (Greek *hudor*, water, and *thorax*, the chest), is the term applied when the accumulation of fluid is considerable. Of course, in the chest the fluid will seek the lowest level, and thus, at first, it will occupy the bottom of the cavity, surrounding the lung, compressing to some extent the extreme parts of the lung; but, as it increases in amount, it will rise, squeezing the air out of the lung as it ascends.

In the ordinary run of cases so much fluid is not poured out as to cause complete collapse of the lung. The inflammation passes away. Processes of repair set in. The poured-out fluid begins to be absorbed partly by blood-vessels, partly by lymphatics (p. 200), and as it diminishes, the lung, released from the pressure, slowly expands. In time the fluid is all removed, the two folds of membrane glide on one another again, and their surfaces being rough, friction is reproduced. Generally also the roughened surfaces become adherent to one another, either in parts or throughout their whole extent, and the pleural cavity ceases to exist. This is practically complete recovery. The case, however, may not end so favourably as this. The lung may have been so much compressed that when the fluid is removed it cannot expand, or can only expand to a slight extent. There being nothing to fill the space it should occupy, the wall of the chest is drawn in, the organs in the chest are pulled over to that side, and the person acquires a peculiar way of holding himself, his shoulder dropping, and his whole body leaning to the affected side. In another way the end may be unfortunate. Matter may be formed in the cavity of the pleura, and an abscess result, which may in time discharge itself into the lung, the matter being spat up, or may point and open to the outside, an open channel leading from the outside to the cavity. This condition is called **empyæma** (Greek *en*, within, and *puon*, matter).

The common **cause** of pleurisy is exposure to cold. It may be caused by injury—a broken rib, for example, pushed inwards and irritating the membrane. Pleurisy is sometimes a complication of various fevers—scarlet fever, typhoid fever, &c.—of kidney disease, of heart disease, and of blood-poisoning. It may also be due to disease of the lungs themselves, some diseased condition of a part of the lung near the surface irritating the lining membrane and setting up pleurisy at the irritated point. A small part only of the pleura may be affected in this way, and no pouring out of fluid occur, but the two folds of membrane become adherent at the irritated part. This is called **dry pleurisy.**

Symptoms.—Usually the first thing of which

a person affected with pleurisy complains is a pain or stitch in the side under the nipple. The pain is of a stabbing or tearing character at a particular place, and does not move about. It is increased by deep breaths, generally becomes intense with coughing, sneezing, &c., and is increased also by moving the arm of that side. Loss of appetite, weakness, feverishness, furred tongue, quick full pulse, short shallow breathing, scanty and high-coloured urine are among the other symptoms. A short, dry cough is also common. The fever does not run very high, 102° or 103°. The conclusive signs are obtained by examining the chest. In the early stage, before fluid has been poured out, the friction sound referred to above may be heard. When effusion has taken place in any quantity, tapping the chest gives out a dull sound, and the breath sounds can no longer be heard (see p. 266). By tapping, the level of the fluid can be ascertained, the person sitting up, for as soon as one taps higher than the level of the fluid, a clear sound is produced. Another method, that even the most unpractised can make use of, is to apply one hand close to each side of the patient, the chest being quite bare, and then to ask the person to speak. The thrill of the voice ought to be communicated equally to each hand. If the pleura on one side is full of fluid, the thrill will be absent on that side. If the lung on one side has become solid, owing to inflammation or other cause, the pleura containing no fluid, the solid lung will conduct the sound even more easily than the lung filled with air, so that while the thrill is felt on both sides, it will be very much increased on the diseased side. When fluid has been poured out, the pain usually begins to subside. In the early stage of the illness the person lies commonly on the sound side, pain preventing him turning on to the other. When much fluid has been poured out, however, he lies on the affected side, for if he were to lie on the sound side, the weight of the fluid on the top side would too much embarrass breathing. With effusion difficulty of breathing is greatly increased, and the person may even become livid, and breathes rapidly. Commencing recovery is indicated by diminished pain and feverishness. But the effusion remains long after the inflammation has passed, as is indicated by the breathlessness on sitting up, or on the slightest exertion. A physician determines the progress towards complete recovery by tapping to discover whether a clearer sound is produced, and by listening to discover the return of the breath sounds.

In some cases the onset of the disease is not well marked, the patient suffering from languor and weakness, with stitch in the side, other symptoms being slight. Perhaps it slowly passes off, without the person being aware that he was affected with a serious disease; perhaps his symptoms increase till he is forced to lay himself up. In other cases the attack is sudden and severe, shivering fits, with high fever and severe stitch, indicating its occurrence.

Among the symptoms of formation of matter are shivering fits followed by sweatings.

Treatment.—The person should from the outset have perfect rest in bed, little talking being allowed, a good dose of opening medicine (epsom or seidlitz salts) being given early, and light nourishing diet being administered without stimulants. Large hot lintseed-meal poultices should be frequently applied to the affected side, to which mustard may be added now and again. A large flannel bandage round the chest should secure the poultices, and a dry one should be applied when the poultices are off. If the pain is severe 1 grain of opium, or 25 drops of laudanum, may be given (to adults only) twice or thrice daily. That will, however, bind the bowels, which should be relieved by additional medicine, or by injections. When recovery has begun moderate nourishing diet is to be given, and quinine and iron tonic, or iodide of iron (a tea-spoonful of the syrup four times daily). To aid the absorption of the fluid, occasional mustard poultices may be applied to the side, or fly-blisters may be used on one part of the side one day, and a day or two after on another part. Rubbing the side is useful if the condition of the skin permits. An occasional dose of medicine is a help.

It must be remembered that, even in favourable cases, the absorption of the fluid poured out takes some time—weeks, and even months. Further, freedom from breathlessness is no sign of absence of fluid, for there may be a considerable accumulation of fluid and little breathlessness. For months after the attack great care must, therefore, be exercised.

Where the collection of fluid is so great as to threaten destruction of the lung, or where matter has formed, physicians now employ methods for the withdrawal of the fluid from without by tapping, that is, making a small opening in the wall of the chest and inserting a fine tube for drawing off the liquid. It is done with precautions to prevent the entrance of air and various impurities.

Pneumothorax is the term applied when there is an accumulation of air in the cavity of the pleura. The air may gain entrance from the outside by a wound, or from the lung by an opening produced by an abscess. It produces difficulty of breathing. If an opening communicates from the outside with the cavity the lung on that side will not expand with the movements of inspiration, because it is easier for the air to enter by the opening to occupy the enlarged space than for it to enter the lungs and overcome their resistance to expansion.

DISEASES OF THE LARYNX, WINDPIPE, AND BRONCHIAL TUBES.

Inflammation.

A description of catarrh, or "cold in the head," is given on page 154, and it has there been pointed out how this condition, beginning in the nose, may extend to the throat and on to the windpipe and bronchial tubes, developing, that is to say, into "cold in the chest." In nasal catarrh the mucous membrane lining the nostrils becomes red and swollen, is easily irritated—even cold air irritating it and causing sneezing—and in a short time pours out a discharge, at first watery and then thick. Now the mucous membrane of the throat is continuous with that of the nostrils, so also is that of the larynx, so also is that of the windpipe. The bronchial tubes, down even to their finest branches and their ultimate endings, are lined with a mucous membrane continuous with that of the windpipe, larynx, and throat, and through them with that of the nose. The inflamed or catarrhal condition of the nostrils may thus extend, through mere continuity of the membrane which it affects, right down the windpipe and bronchial tubes. Moreover, any part of this continuous membrane may be separately affected by a catarrhal condition. But in whatever part of the mucous membrane the catarrh appears, it exhibits essentially the same characters, any differences that may be observed being due, not to any change in the nature of the inflammation, but simply to the position which it occupies. Thus inflammation of the larynx, inflammation of the windpipe, and inflammation of the bronchial tubes, are simply forms of catarrh in different situations.

Inflammation of the Larynx (*Laryngitis*). Here the changes already alluded to affect the mucous membrane of the larynx. The membrane becomes red, swollen, and at first dry; later the membrane secretes fluid which soon becomes thick and glairy, and contains pus. The inflammation passes off gradually, by the membrane becoming less engorged with blood, and less swollen, but a relaxed condition is apt to remain for some time.

The **causes** of the disease are usually exposure to wet or cold. The inflammation may also be due to the direct action on the membrane of some irritation. For example, the fumes emitted from some forms of galvanic cells—Bunsen's or Grove's cell, for instance—are extremely irritating to the throat, and if one incautiously works in the room where a battery of such cells is, inhaling the fumes is apt to provoke an attack of laryngitis. In some diseases of the lung the matters that are brought up are irritating to the larynx and windpipe. Violent exertion in speaking or shouting may also be a cause. In various other diseases, small-pox, measles, scarlet fever, kidney disease, this affection may be a complication. Thus it is not uncommon to find children developing suddenly the signs of laryngitis, the hoarse barking cough, altered voice, &c., with fever, that make the parents believe croup to be coming on, and next day the cause is revealed by an abundant crop of the eruption of measles. The poison in the blood, that is to say, has inflamed the mucous membrane of the larynx as it has inflamed that of the eyes and nose, as the streaming eyes and sneezing testify.

Symptoms.—That the affection is the result of a cold is frequently evident by a previous "cold in the head,"—hoarseness, perhaps loss of voice, soreness referred to the larynx, and irritable cough, coming in spasms and easily excited by a deep breath or by breathing a cold atmosphere after a warm one, being its chief signs. Such an attack passes off in a few days. In a more severe form, attended by fever and quick pulse, there is aching or actual pain, and perhaps even pain on pressure on the larynx (Adam's apple) from without. Swallowing increases the pain. The person may at first think the pain is due to a fish-bone that has stuck deep down in the throat. Spasms of coughing occur, the cough being hoarse and rough. The voice is altered, perhaps lost. All this is due to the redness, dryness, and swelling of the membrane. But the swelling in very severe cases may seriously impede breathing by obstructing the passage, and then the breathing is wheezy and whistling. Perhaps the patient gasps for breath and has all the appearance of one struggling against suffocation, the eyes being pro-

minent and face livid and bathed in sweat. If not relieved the patient becomes delirious and sinks into insensibility owing to the blood being charged with carbonic acid gas. Such acute cases are only found in adults, and generally take such a fatal form because of an enfeebled constitution.

A chronic form of the mild type of laryngitis is the cause of what is called clergyman's sore throat, which is considered under AFFECTIONS OF THE VOICE at page 287. Chronic forms of the disease ending in ulceration attend tubercular consumption and syphilis, and are the cause of hoarseness and loss of voice in these affections.

Treatment.—Hot cloths and poultices should be applied directly over the front of the neck. If these fail to give relief, or if the case be urgent, mustard poultices or blisters may be applied. These, however, should not be placed directly over the larynx, but over the upper part of the breast-bone. The reason is that if the blisters or mustard were placed directly over the larynx, the swelling they produce would extend to the larynx, because of its nearness to the surface. The person should be in bed in a room kept warm and free from cold draughts. Breathing steam will relieve the irritability of the throat, and to the same end a kettle should be placed on the fire and allowed to pour its steam into the room. For this the bronchitis kettle is best. (See MEDICAL AND SURGICAL APPLIANCES.) Hot drinks are also beneficial; and the bowels should be unloaded by a good dose of salts. In ordinary cases these measures will be sufficient. Persons of weak health must have their strength maintained by nourishing soups. Sometimes stimulants are necessary. But cases of this kind ought to be in charge of a qualified physician. In cases where suffocation is threatened, instant relief may be given by the performance by a surgeon of **tracheotomy.** This consists in opening the windpipe from the outside and inserting a tube. The patient breathes through this new opening till the swelling has subsided, when the tube is withdrawn and the wound closed.

In chronic cases blisters may be applied outside, but the most effective treatment consists in the direct application to the membrane of astringent remedies in the form of spray, powder, or paint applied as mentioned in the paragraphs on AFFECTIONS OF VOICE (p. 286).

Dropsy of the Larynx (*Œdema*) is a condition in which great swelling—sometimes threatening suffocation—is produced by the pouring out of fluid from blood-vessels in the loose tissue under the mucous membrane. It is due sometimes to the swallowing of scalding liquids, and sometimes comes on after erysipelas and scarlet fever. It may be caused by inflammation, or be apart from it. It can best be relieved in dangerous cases by tracheotomy, as above mentioned, or by a surgeon passing a lancet down the throat and scraping the part to permit the fluid to escape and the swelling thereby to subside. If scalding has been the cause, relief may be obtained by ice applied to the throat.

Inflammation of the Windpipe (*Tracheitis;* Latin *trachia*, the windpipe) is very similar to inflammation of the larynx. It also may be a mere accompaniment of a common cold. **Croup** is a special kind of inflammation of the windpipe, and is considered in Section XIII. p. 417. The ordinary form is accompanied by fever, some pain in the windpipe, spasmodic coughing, &c., as in the affection of the larynx. There is not the same pain in swallowing, however, nor need the voice be affected if the inflammation is confined to the windpipe.

Treatment is the same as for laryngitis.

Bronchitis is a catarrhal inflammation of the bronchial tubes. In it, as in the ordinary catarrh, the lining membrane of the tubes is congested, dry, and swollen. Thereafter fluid is poured out from the gorged vessels, and the secretion becomes, in the later stages, thick and containing matter.

Its causes are chiefly exposure to cold, or the inhalation of irritating substances, or it is due to some fever, hooping-cough, &c.

Symptoms.—There is fever, preceded probably by chills. The pulse is quick, the breathing hurried, and the tongue furred. Appetite is lost; the bowels are confined; there are thirst, headache, and weariness. The special symptoms are due to the condition of the bronchial tubes. They are pain, a sense of tightening in the chest, difficulty of breathing, and a dry, irritable cough. These are due to the congestion and swelling of the mucous membrane of the tubes. The cough is occasioned by the air passing over an irritable surface; and sometimes the patient has a feeling as if a tract within the chest and down the line of the breast-bone were raw. At this time, if one listens with the ear to the chest, whistling, cooing, or piping sounds are heard with the move-

ments of breathing, caused by the air rushing along narrowed tubes. By and by the cough is accompanied by a spit of clear mucus, the secretion from the inflamed membrane. The spit soon grows more abundant, and becomes yellowish. The sounds heard in the chest are now not so musical, but more of a bubbling character, called **crepitation**, occasioned by the air passing through the fluid in the tubes. The bubbling is coarse or fine as the inflammation is in larger or smaller tubes. As the case progresses the cough becomes less and the discharges diminish in amount. The sounds in the chest gradually become replaced by the fine rustle of ordinary breathing. The attack may last only a few days, or may go on for some weeks. In what is called **capillary bronchitis** the disease attacks specially the finer tubes. The very young or old are particularly liable to it. Breathing is in this form very difficult and laboured. The patient's skin is livid, and the blue veins are well marked over it, while the distress may be excessive. The spit is not so profuse as in the bronchitis of the larger tubes. It more readily tends to death from suffocation or exhaustion.

Treatment.—The person should be confined to a moderately warm room, the air of which is kept moist by a constant stream of steam from a kettle. A particular kind of kettle—the bronchitis kettle—may be used for this purpose. (See Plate VIII.—NURSERY APPLIANCES.) Large warm poultices should be applied to the chest. The bronchitis may be confined to one side, or may affect both. This is determined by listening to the breath sounds. If it is limited to one side the hot applications should be placed on that side only. The poultices may or may not contain mustard, according to the severity of the attack. Let the bowels be opened by a dose of medicine, castor-oil, senna, or seidlitz-powders; and let the food consist of milk, warm broth or soup, free of vegetables, beef-tea, &c. This in an ordinary case is sufficient. After mucus has begun to come away it may be aided by a mixture of syrup of squills and ipecacuanha (see PRESCRIPTIONS—COUGH MIXTURES). But let people beware of the ordinary cough mixtures, chlorodyne cough mixtures and the like. They are very valuable in many cases, but they ought to be given with great discrimination. In some cases of bronchitis, where the tubes are loaded with mucus, the constant coming up of which maintains a harassing cough, cough mixtures containing chlorodyne or laudanum will greatly relieve, but *at the expense of letting the discharge accumulate in the tubes to block up the lungs.* If any preparation of opium is given at all, it is only in the early stage, when the cough is violent and excessive, and *dry*, that is, unaccompanied by spit. Then it may be given in 8 to 10 drop doses, with 20 drops ipecacuanha wine, repeated every three or four hours. *It should never be given when the breathing seems obstructed, and the skin and lips have the least suspicion of blueness; indeed its administration should be left entirely to a medical man.* Ipecacuanha may, however, be given in often-repeated doses, and specially when the spit is thick and tough. Stimulants are frequently necessary, but are to be given only according to medical advice.

Chronic Bronchitis.—Bronchitis may exist in a chronic form either as a result of an acute attack, as a consequence of long-continued irritation, or as a complication in other diseases. Diseases of the heart or kidneys, for example, or gout are frequently associated with it. It is mostly in adults, those in middle and advanced life, that it occurs, but it is found also among the young, though it is probably continued in them owing to some bad constitutional condition.

Its main **symptoms** are cough, shortness of breath, and spit. It is particularly apt to attack a person in winter, or during a season of bad weather, continuing until the return of warmer weather, a new attack coming on with the succeeding winter, forming the condition known as **winter cough.** Foggy weather is particularly disagreeable to a subject of chronic bronchitis, a short exposure to the fog usually occasioning the cough and shortness of breath within a very short time. The intervals of good health become shorter, and the duration of each successive attack longer, till perhaps the person is seldom free from some sign of the disease, which is easily aggravated. In such confirmed cases the person becomes markedly rounded in the shoulders, and the chest assumes frequently more or less of a barrel shape. This is partly due to a condition called **emphysema**, in which parts of the lungs become unduly expanded to compensate for other parts rendered more or less unfit for their duty. The discharge from the bronchial tubes of chronic bronchitic patients varies, sometimes being very abundant and watery, or thick and yellowish, sometimes being very scanty. In some cases it is very badly smelling. As a result of the condition of the lungs, other organs

frequently suffer—the heart, liver, and kidneys—and death in the end may be due, not only to the lungs becoming more and more unfit for work, but also to the complications, to exhaustion, &c.

Treatment.—The patient should be exposed as little as possible to any considerable change of temperature, and should not go out into the early morning air or night air. Wet and cold feet should be specially guarded against. The body should always be warmly clothed, flannel being next the skin. The room in which the person sleeps ought to be moderately warm. Good, nourishing diet in moderate quantity is necessary. Small doses of stimulants are often valuable, but the need of them must be decided on in each case on its merits, and by a competent person, not according to the person's notions. Tonic medicines are required. The ammonia and senega mixture mentioned under PRESCRIPTIONS—COUGH MIXTURES, will be found valuable. Cod-liver oil, if it can be taken, is very serviceable in chronic bronchitis attended with much spit. The writer has found of great use the wearing of a respirator, of a form to permit of cotton wool or lint, soaked in some weak carbolic acid or creosote solution, being placed within it. Its use is described under MEDICAL AND SURGICAL APPLIANCES. Inhalation of the vapour of drugs in this way, and of thymol, subdues the smell in fetid bronchitis. During an aggravation of the attack mustard poultices should be applied to the chest, or cloths sprinkled with turpentine, on the top of which hot flannel cloths are bound.

If the person can remove during winter to a temperate climate he will be greatly benefited and relieved.

It is probably advisable to add a word of warning to sufferers from this common affection. In their eagerness for relief they will try any remedy that promises to do good. Patent medicines are run after. Now relief to the cough can easily be had. At least preparations of opium will greatly subdue it, but in most cases it will be at the risk of adding to the evil by permitting the bronchial tubes to become charged with secretion that otherwise would have been expelled.

Ulceration of the larynx, windpipe, or bronchial tubes is not a common result of ordinary inflammation. It may, however, occur in any of these situations during the progress of consumption. The material brought up from the diseased lungs being of a very irritating character, may produce congestion at various parts of the air-passages in its upward course, and lead to a breach of surface and the formation of shallow ulcers. Tubercles may be present in the mucous lining of the bronchial tubes or other parts of the air-passages, and are also a common cause of ulceration, even as they tend to the formation of ulcers in the mucous lining of the bowels (p. 165). Another special cause of ulceration of the air-passages is syphilis.

Bronchiectasis (Greek *ektasis*, widening) is the term applied to a condition in which the bronchial tubes are widened in some part of their course. It is a consequence most commonly of chronic bronchitis. One result likely to occur is that the widened tubes retain a considerable quantity of the matter, which is usually copious, and that it decomposes, so that the spit has an offensive smell.

Spasm of the Larynx and Bronchial Tubes: Asthma.

Spasm of the Larynx. The opening in the larynx, the **glottis** (p. 250), as it is called, that affords a passage for air between the windpipe and upper parts of the throat, is not a very wide opening. It is also capable of being widened or contracted by muscles that surround it. It is when it is contracted to a narrow slit and air forced rapidly through it that voice is produced (p. 263). Now the contraction of muscles that produces the narrowing of the opening is effected by nerves, laryngeal nerves; and if these nerves be stimulated in any way the contraction of the muscles, and the narrowing of the aperture of the glottis, will result. In spasm of the larynx the nerves are irritated in some way or other, the muscles suddenly contract, and the opening is greatly narrowed, so that the breath is drawn in with great difficulty. The narrowing may be so great that the opening is entirely closed, and then no air can be drawn in at all. The spasm may be due to inhaling very irritating vapour, or to some irritating substance finding its way into the larynx. We all know how, when something we are eating or drinking "goes the wrong way," there is a sudden feeling of suffocation, great difficulty of drawing breath, accompanied by spasmodic attempts at coughing. The substance has entered the larynx and so irritated it that the glottis has spasmodically closed, while at the same time involuntary efforts to expel the offending substance are made. When the spasm yields there is often a long-drawn shrill sound,

to which the term "hoop" is given, accompanying inspiration, due to the air rushing past the still narrow opening. Such spasms of the larynx are features in hooping-cough, so called because the hoop is specially characteristic of the disease, and in other disorders. Sometimes spasm of the larynx is due to irritation of one of the laryngeal nerves, caused by the growth of a tumour pressing on the nerve: it also occurs in hysteria. **Child-crowing** (*laryngismus stridulus*) is a spasm of the larynx. It is discussed under DISEASES OF CHILDREN.

The **treatment** depends on the cause. If irritating vapour has set up a spasmodic condition, breathing of steam is useful as well as hot applications to the throat. In many cases inhaling the vapour of ether or chloroform acts like magic; but it must be superintended by some competent person. In hysterical and nervous cases dashing cold water over the chest causes the spasm to relax.

Asthma (Greek *asthma*, panting) is an affection due to a spasm of the bronchial tubes, causing great difficulty of breathing. The bronchial tubes have a middle coat of muscular fibres (p. 251). If they contract they will diminish the extent of passage in the tube. In the walls of the smallest bronchial tubes there are no plates of gristle to keep the tubes open; thus contraction of the muscular fibres will readily narrow them, and, if it be excessive, close them altogether, so that air can no longer pass along the affected tubes till the spasm is relaxed. The amount of contraction is regulated by the nervous system, so that some irritable condition of the nerves supplying the bronchial tubes may occasion tonic contraction of the bronchial tubes, an attack of asthma.

Causes.—True asthma is thus a nervous disease; but the nervous irritation giving rise to an attack may be produced by many causes. It is a disease not unfrequently handed down from parent to child, showing itself perhaps in infancy, and most commonly at least before the tenth year. But it may begin at any period of life. The immediate cause of an attack may be the inhalation of irritating vapour or dust. It is a peculiar disease in this respect that the circumstances exciting an attack vary with each individual who is subject to it. Thus the smell of new-mown hay brings on a spasm in one, in others, the smell of some particular flower, or some particular animal, cat, dog, hare, rabbit, &c., or of some particular drug, for example, ipecacuanha powder. Some asthmatics suffer in one kind of atmosphere, others in an atmosphere of a totally different kind. Each person has to determine for himself what is not hurtful to him. Some asthmatics can live in one place for only one period of the year, and must remove elsewhere for other periods. Again, indigestion, a loaded condition of the bowels, states of the heart, liver, and kidneys, may all occasion asthmatic attacks.

Symptoms.—An attack may come on suddenly, or may be preceded by drowsiness and a sense of tightness and constriction in the chest. A peculiar itching of the chin, not relieved by scratching, is in some cases a forerunner of the attack. It commonly comes on at a particular hour, and generally in the middle of the night. The chief symptom is intense difficulty of breathing, which compels the patient to rise from his bed and place himself in the position that will enable him to expand his chest to the utmost for the entrance of air. He throws off clothing, and raises his shoulders; if there is anything above him convenient for the purpose he grasps it with his hands, thus fixing his shoulders in an elevated position and enabling his muscles to act from a fixed point in expanding the chest. Every attitude indicates a struggle for breath. His face expresses great anxiety; his eyes are prominent, his skin pale or bluish, and perspiration breaks out over his body. The breathing is attended with great wheezing.

The spasm may last for only a few minutes or for several hours. It may be present in a mild form for some time. When it passes off cough comes on, and with the cough a small amount of mucus is frequently discharged, but not in sufficient quantity to account for the difficulty of breathing. It usually recurs at more or less regular intervals or seasons. An asthmatic individual may live to a good age. The disease sometimes disappears in adult life when it has appeared in infancy, but it is usually lifelong. Repeated attacks are apt to occasion changes in the lungs, and changes connected with the heart.

Treatment.—In many cases a good dose of opening medicine, or an injection to unload the bowels, given at the very beginning, wonderfully relieves. Many remedies are used during the attack to relieve the spasm. Smoking ordinary tobacco, or better, stramonium (thorn-apple) sometimes does so. The stramonium is put in a pipe along with tobacco or alone, and a few whiffs taken. Inhalation of chloroform is beneficial, but its administration *must not* be attempted by the patient without some competent

person at hand. Nitrate of amyl has recently been largely used with some success. Five drops are placed on a handkerchief, which is held over nose and mouth, and inhaled till the person feels giddiness in the head, and the face is flushed and the eyes red. It ought not to be used by full-blooded persons, and indeed by no one without competent advice, for it may produce unconsciousness from the rush of blood to the head. A patent medicine—Himrod's cure—has proved very useful in many cases. It is a powder, and is burnt, the person inhaling some of the fumes. In the same way an asthmatic person will often find relief from burning in his room paper which has been dipped in a solution of saltpetre and then dried.[1] Relief is sometimes also to be had by taking a mixture containing 10 grains iodide of potassium dissolved in a little water, with 10 drops sal volatile (aromatic spirits of ammonia), 10 drops spirits of ether, and 10 drops tincture of belladonna. This dose may be repeated every six hours. Further, 10 drops of tincture of belladonna, with water only, taken every two or three hours, are of great use in the attack. The dose should be reduced if any bad effects—excitement, &c.—arise. The asthmatic patient should do all he can to diminish his tendency to attacks by taking simple nourishing diet, by keeping the bowels regular, perhaps by an occasional dose of rhubarb to relieve the liver. During the intervals also 5 grains of iodide of potassium may be taken thrice daily in water, and may be persevered in if, after some time, it is found to benefit the patient. An asthmatic person should try to discover what sort of climate suits him.

Hay-Asthma (*Hay-fever*) is a kind of catarrh to which some persons, not many, are liable during the months of May, June, and July, and which is supposed to be excited by particles from new-mown hay and other flowering grasses entering the air-tubes and setting up inflammation. Attacks have even been induced in persons by dust from dried hay. Dust from powdered ipecacuanha also produces the affection in some.

The **symptoms** are watering, redness, and itching of the eyes, irritation of the nostrils, accompanied by violent sneezing and much discharge, and similar irritation of throat, with cough, difficulty of breathing, tightness of the chest, sometimes with copious spit, &c.

Treatment.—The best treatment is the avoidance of the exciting cause by the person going to the seaside or to a place barren of grass during the months when the disease prevails. The wearing of a respirator made of a double fold of cambric to intercept the irritating particles is suggested. Many persons have found relief by taking 3–5 drops of the liquor arsenicalis of the British Pharmacopœia after each meal. Inhaling steam, tobacco, or stramonium smoke has also been useful.

[1] To prepare the paper, dissolve 4 ounces of nitre in half a pint of boiling water; soak thick red blotting-paper in it, then drain the paper and dry it. Burn, at one time, two or three pieces 4 inches square in the patient's room.

Tumours, Foreign Bodies, &c.

Tumours occur in the larynx and other portions of the air-passages. A not uncommon form is that of warty growths in the neighbourhood of the vocal cords.

The **symptoms** are hoarseness and loss of voice, croupy cough, difficulty of breathing, and sometimes spasmodic attacks of obstructed breathing

The **treatment** is removal of the tumour by a surgeon. In some cases where suffocation is threatened opening of the windpipe is necessary to save life.

Foreign bodies of various kinds are common in larynx, windpipe, and bronchial tubes. It may be something one is eating passes suddenly backwards into the air-passages while the person is talking or laughing; or it may be a coin, pebble, button, or some such thing, one has been holding in the mouth, &c.

The **symptoms** and appropriate **treatment** are considered in the chapter on ACCIDENTS AND EMERGENCIES under the heading CHOKING.

DISEASES OF THE LUNGS.

Inflammation, Congestion, &c.

Inflammation of the Lungs (*Pneumonia*). This form of inflammation of the respiratory organs attacks specially the air-cells of the lungs, the lung substance itself. A description of the regular form will enable one to understand the nature of the disease.

The blood-vessels of the affected part of the lung are engorged with blood, specially the blood-vessels in the walls of the air-cells (p. 252), and also the vessels in the walls of the passages and fine bronchial tubes communicating with them. The pressure of blood in the vessels causes fluid (serum) to ooze from them and enter

the cells and passages. As the inflammation continues, besides serum, other parts of the blood escape, namely, fibrin and also blood corpuscles (p. 214). This material completely expels the air from the affected portion of the lung, which thus becomes heavy and solid, and, being capable of clotting, the material forms a gelatinous mass in the air-cells. In the next stage of the disease this inflammatory material breaks down into matter, which is more liquid, and may be expelled from the air cavities and cells. As it is gradually expelled, coughed up, and spat out, the air spaces become unloaded, and air begins again to pass into them. If the case has pursued an entirely favourable course, the inflamed portion of lung will, after some time, be restored to its former activity and usefulness, with little trace of the serious changes it has passed through. There are thus three stages in the progress of the disease. The first stage is that of *congestion* or *engorgement*, the second is called that of *red hepatisation*, from Greek *hepar*, the liver, because the solidified part of the lung looks like a piece of liver, being red in colour owing to colouring matter of the blood; the third stage is that of *grey hepatisation*, the change in colour being due to breaking down of the contents of the air-cells.

Inflammation attacks the right lung twice as often as the left; and generally it is the lower parts of the lung that suffer, both lungs not often being inflamed at the same time. In the typical form a whole lobe is the seat of the inflammation, the lower lobe usually, but the upper lobes may also be affected. Hence the term **lobar pneumonia** has been used to distinguish from **lobular pneumonia**, which attacks the lungs in patches, separated by healthy lung tissue, and is more common among young children than among adults. The latter form is also called **catarrhal pneumonia**, since it is frequently a termination of catarrh or cold in the chest. It may also be stated that lobar pneumonia is also called **croupous**, because of the fibrinous material poured into the air-cells that characterizes the typical case. In most cases of pneumonia there is some amount of bronchitis (p. 270), owing to the affection of the smaller bronchial tubes. There may be also pleurisy (p. 266), that part of the pleura which is in contact with the inflamed portion of lung suffering with it. When the pleurisy is marked the doubled affection is called **pleuro-pneumonia**.

The pneumonia may not end, however, so favourably as has been supposed. A fatal termination may be due to the extent and violence of the attack, or to weakness, the heart being specially liable to fail because of the extra work thrown upon it in urging the blood through the obstructed lung. A chronic condition may be set up, which is considered later. In some cases, comparatively few, and only in those of very weakened constitutions, who suffer probably from other disease, the pneumonia ends in a part of the lung dying, and breaking down into fetid matter. This constitutes **gangrene of the lung**.

The chief **cause** of the disease is exposure to cold, and specially to sudden considerable variations of temperature, so that it is common in spring. It may, however, arise from extension of inflammation from the pleuræ or the bronchial tubes. Thus a common cold, neglected, may end in pneumonia. Other inflammations—those attending hooping-cough, measles, diphtheria, &c. —may occasion it, while it may arise in the course of other diseases, such as those of the heart, kidney, &c. Inhalation of irritating vapours or particles is another cause. For example, the solid particles inhaled by miners, knife-grinders, &c., are capable of producing it. Drinking a large quantity of cold water in an overheated condition of the body, by driving the blood from the organs of the belly to the lungs, may bring on an attack.

Symptoms.—The attack usually commences with fever, preceded in adults by severe shiverings, and sometimes in children by an attack of convulsions. The fever is sometimes very high, running to 104° and 106°. Within a short time, 24 hours or so, the nature of the disease is indicated by pain in the chest, rapid, shallow breathing, and cough, at first dry, but afterwards attended by a characteristic spit. The pulse is rapid, but not so much quickened as the breathing. The face is flushed, perhaps livid; the skin is dry and hot; the tongue is furred; appetite is lost; there is headache; and the urine is scanty and highly coloured. The patient should be made to spit into a dish. What is put up is at first rust-coloured, and so thick and gelatinous that it sticks to the dish and will not fall out though the vessel be turned upside down. This indicates that the disease is in what has been described as the second stage. In a few days the spit becomes more fluid and yellowish. Sometimes, however, there is little spit. Delirium is an occasional symptom, and is rather a serious one if marked. A common symptom is an eruption of watery blisters on the lips. The condition of the lung

can be readily ascertained by an examination such as described on p. 266. At the onset of the disease a fine crackling sound is heard, which soon disappears, the usual sound of air entering and leaving the air-cells being no longer heard, and a dull sound being produced by tapping the chest over the affected part, because that part is solid. When the matter begins to be expelled, the return of air is signified by the return of the crackling sound, and progress to recovery is indicated by the gradual restoration of the healthy sounds.

Recovery should begin about the fifth or seventh day by a disappearance of the fever. In about a fortnight the disease runs its course, though it may last only a few days or may be much prolonged.

Gangrene is indicated by the spit being fetid.

Treatment.—The person must be strictly confined to bed in a room kept moderately warm, but having a due supply of fresh air. A dose of castor-oil or seidlitz-powder should be given to open the bowels freely, and an ordinary motion should be obtained daily. Light but nourishing diet is to be administered, milk, beef-tea, &c., and water to quench thirst should not be denied. Occasional large poultices to the affected side, or flannel cloths sprinkled with turpentine, and covered with thick folds of warm flannel, will help to relieve the pain and difficulty of breathing. This is the kind of treatment, and in ordinary cases is sufficient with careful and attentive nursing. The acetate of ammonia mixture may be given (PRESCRIPTIONS—FEVER MIXTURES). In cases of exhaustion or weakening of the heart, stimulants are required, the carbonate of ammonia and senega mixture (STIMULANT MIXTURES), or wine, brandy, or whisky. These are not to be given without occasion. The disease, however, is so serious a one, and the details of treatment depend so much upon the individual affected, that no delay should be permitted in summoning a physician.

During recovery nourishing food, eggs, animal food, &c., are required, and quinine and iron tonic, cod-liver oil, &c., are advisable. For some time after the attack the person ought to exercise great care, since the lung cannot be supposed to recover its ordinary condition for a very considerable time after all signs of disease have disappeared.

Chronic Pneumonia (*Fibroid Phthisis* (consumption)—*Cirrhosis*) consists in a growth of fibrous tissue round the bronchial tubes and air-cells, gradually encroaching on them till the lung tissue is converted into dense, hard material. This newly-formed material in time shrinks, and in this way still further destroys the lung substance. It may also in parts break down, and cavities are thus formed.

Its causes are occasionally preceding acute pneumonia, bronchitis, &c. Inhalation of solid particles, such as miners, mill-stone grinders, colliers, flax-dressers, knife-grinders, stone-cutters, are exposed to, may also produce it. It is thus known as knife-grinder's consumption, stone-cutter's consumption, &c.

The **symptoms** are chiefly gradually increasing weakness, loss of flesh, more or less difficulty of breathing, and cough, with or without spit, which is often considerable, however. Sometimes spitting of blood occurs, and dropsy arises from the weakened condition of the heart which the disease produces.

The disease may be prolonged for many years.

Treatment consists in good food, fresh air, removal to a warm and equable climate, and tonics, such as quinine and iron, cod-liver oil, &c.

Congestion of the Lungs is a term in very common use, being often employed where in reality inflammation of bronchial tubes or air-cells is present. Of course congestion is always present in inflammation, the vessels being engorged or congested with blood before the proper features of inflammation have developed. Doubtless in some cases the state of congestion passes off without actual inflammation being developed. But a state of congestion independent of actual inflammation does occur, specially in diseases of the h art and during the progress of fevers. Thus wh re there is valve disease (p. 239) of the left side of the heart, in particular mitral valve disease, the blood does not pass onwards into the arteries with due rapidity, and becomes blocked in the auricles. The overfull condition passes backwards along the pulmonary veins (p. 223) till the lungs are reached, and there the vessels in turn become overfull, so that the pulmonary blood-vessels are engorged. Fluid escapes from them and pervades the lung tissue, which becomes dark, empty of air, and dropsical. This is apt to lead to active inflammation or to gangrene (death) of parts of the lung. Blood-vessels may burst and bleeding occur, the blood being partly expelled by the mouth, and partly poured out among the lung tissue, forming **pulmonary apoplexy**. Such congestion is not active but *passive*, the blood simply collects because it cannot pass onwards. In fevers, espe-

cially exhausting fevers like typhoid, the heart shares in the general weakness, and may become unable to propel the blood with sufficient vigour, so that congestion arises through enfeebled circulation. Old persons, or persons of weak condition of body, if kept lying in bed on the back for any length of time, as for example with a broken leg, &c., are liable to congestion, simply because the weight of the lung itself, with the person in the recumbent position, prevents due circulation. Such persons ought to be propped up occasionally to avoid this.

The **symptoms** are difficulty of breathing, perhaps bluish appearance of skin, and cough, with blood-stained watery spit.

Treatment.—The condition is a serious one, and calls for immediate attention and careful treatment, for one cannot tell how extensive the congestion may become in a short time. Treatment may require to be directed to the heart to strengthen it. Stimulants may be necessary. There can be no harm in the use of warm applications to the chest, specially low down on the back. But skill and knowledge are requisite to determine in each case the cause of the condition and its appropriate treatment.

Consumption and Spitting of Blood.

Consumption (*Phthisis*, from Greek *phthino*, to waste away—*Tubercle*—*Decline*).—This is a disease for which the name consumption, or a wasting away, is a very appropriate term. It is characterized by a breaking down of the lung substance into matter. Portions of lung become thus converted into collections of more or less liquid material; and if this matter passes into the air-tubes and is expelled from the lung in the form of spit, cavities remain.

There has been and is yet, however, great difference of opinion as to the real nature and cause of the disease. The general account given here is in accordance with the views of very eminent authorities, and explains what is continually being met with in experience.

Suppose a person is seized with inflammation of the lung. The changes, described on p. 274, go on in the affected lung, material is poured out of the blood-vessels and fills up the air-cells, so that the spongy character of the lung is lost, and it becomes solid, more like a piece of liver. If the case goes on well the deposited material is gradually removed from the air-cells, being partly picked up by lymphatic vessels (p. 200) and partly being passed up the air-passages and expelled in the spit. Air returns gradually to the cells and the work of the lung is resumed. Now it may be that for some reason or other the foreign material poured into the air-cells is not thus removed. Some circumstance, or circumstances, we need not now consider of what sort, prevents this favourable issue, and the matter is allowed to block up the lung tissue. But it is of low vitality, and by and by, after a longer or shorter interval, it tends to be converted into a sort of curdy or cheesy substance. Not only is it itself of low vitality, but its mere presence in the air-cells and the pressure it exerts upon their walls seriously diminish the vitality of the lung texture, which tends to become involved in the degenerative process. There may, therefore, be a part of the lung in which not only the inflammatory contents of the air-cells have become converted into cheesy substance but the tissue of the air-cells itself, so that the affected part of the lung becomes for ever useless. In course of time, moreover, the cheesy mass may become liquid, pass in portions into the bronchial tubes, and be spat up until the whole of the broken-down piece of lung has been expelled, a cavity being thus formed in the substance of the lung. This may occur in different parts of the lung, so that cavities are scattered through it here and there. Sometimes two cavities may exist near one another and finally open into one another, so that they form one irregularly shaped cavity. Sometimes, with the expulsion of the dead matters and the formation of the cavity, further breaking down may cease, the process not extending. In such a case the lung substance round the cavity gradually contracts upon it, diminishing its extent till it has been obliterated and only a scar is left in the lung to mark where it had been. This would be a case of natural recovery. It is, however, common for the wasting process to go on in the walls of the cavity, which gradually break down, so that the space becomes more and more extended, until even almost the whole of one lung may be converted into a single large sac. Into the cavities bronchial tubes open.

In a similar way to that just described may catarrh, such as that beginning in a common cold or in an attack of bronchitis, lead up to the development of consumption. Very specially to that form of inflammation of the lungs called catarrhal pneumonia (p. 275) are numerous cases of decline attributed. The air-cells become inflamed and filled with the products of the catarrhal condition, which undergo degeneration

and carry the texture of the lung with them in their decay.

Cases of consumption are very frequently met with in which the earliest occurrence seems to be bleeding from the lungs. Consumption produced by such an accident has been explained by supposing that the blood from the ruptured vessel has poured down bronchial tubes and filled up the air-cells in which they ended. In time the clotted blood has undergone the process of becoming liquefied, in which the air-cells have partaken, being unable to resist the evil effects of the continued presence and pressure of the blood.

Thus, put briefly and generally, the changes occurring in the lung in consumption are—the lung or part of it affected becomes solid by its air-cells, and bronchial tubes also, to some extent, becoming occupied by products of inflammation or foreign material of one kind or another. These become transformed into dead cheesy substances, and finally break down into liquid matters, the lung tissue being involved in the decaying process.

It is important to notice also that the cause of the irritation which starts the diseased process in the lungs may be fine solid particles drawn in with the breath, such as knife-grinders, miners, millstone-grinders, &c., are exposed to.

Another cause of consumption remains to be considered, which, according to some, is the only real cause of all cases, and that is tubercle. The relation of tubercle to consumption of the bowels is briefly noticed on pages 165 and 166, and there also the nature of tubercle has been described. Tubercles consist of small greyish nodules about the size of a mustard or millet seed. They are formed of cells, are of low vitality, and tend to break down. Softening begins in the centre of the nodule, and spreads till the nodule is converted into a yellowish mass of a cheesy character. The process spreads, and so the broken-down mass becomes gradually larger; the tissue, in which the nodules are situated, being involved, is destroyed in the course of the disease; neighbouring tubercles by their spreading meet, and so a large mass of the tissue may be hopelessly broken down. But the process may be arrested by the cheesy mass undergoing a chalky change and a sort of wall being formed which bars its advance. Now the lungs are a favourite seat of tubercle and specially liable to attack if the disease is present in any other part of the body. As a result of the deposit of tubercle in the lungs, as well as on account of the inflammatory changes that accompany it, the spongy character of the portion of lung attacked is lost and it becomes more or less solid or *consolidated.* The air-cells are filled and the tissue surrounding them invaded by a grey smooth gelatinous-looking material — the tuberculous matter. As this begins to soften it becomes yellow and opaque. Usually it becomes liquid, the substance of the lung involved with it sharing its fate, so that an abscess is formed in the lung. If this finds its way to a bronchial tube it is spat up and a cavity will mark the place which it previously occupied. If the process continue the cavity enlarges, as already described, or the cavity may be surrounded by a sort of capsule formed of condensed lung tissue, which shrinks, causing the cavity to contract. In short, the progress of tubercular consumption is the same as that described as due to inflammation of the lung, the only difference being in the alleged cause.

Of recent years Dr. Koch of Berlin has declared the cause of tubercle to be a minute rod-like organism, called the **tubercle bacillus,** which he has succeeded in growing in nourishing solutions in flasks, and which, injected into animals, produced an attack of tubercle. He has detected the bacillus in the spit of consumptive patients. It is not destroyed by drying, so that the spit of a patient suffering from tubercle may by drying be scattered as dust through the air, may be inhaled by a person whose habit of body makes him an easy prey to the disease, may take root in his lungs or air-passages, proceed to grow there, and develop the full-blown disease. If, then, these views are correct, the popular notion that a consumptive person may infect a healthy person with whom he resides, or with whom he sleeps, appears to be supported by facts. It may, thus, be that all cases of tubercular consumption—and according to some all cases of consumption are tubercular—are due to the action of an organism, the bacillus, which has gained entrance to the body. It should be stated, however, that various experimenters have apparently succeeded in producing tubercle in animals by injecting into their bodies matter and putrid material of various kinds, and by other means. That tubercle is one cause of consumption is certain, that tubercle can be produced by a special organism Koch seems to have proved, but whether it may be produced by other causes is not yet certain.

Particular parts of the lung are more apt to be attacked by tubercle than others. The upper parts of the lung, the apices, and specially the

apex of the *left* lung, are the favourite places where the destructive process begins, from which it tends to travel downwards.

Predisposing Causes of Consumption.—A seed may be sown in the ground, but it does not necessarily take root, grow, and flourish. Supposing a special germ to be the cause of consumption, a person may be exposed to it, but his body may not be a fit place for its growth. He may resist it successfully, in short. Just as two men may walk together into a fever patient's room, may be exposed to the same degree, and leave together, and while one "catches" the fever the other escapes. Still more, if consumption be not always caused by a germ, but is often the result of various unhealthy conditions operating on a particular constitution, still more will one man escape while another falls a victim. The various conditions, or predisposing causes, which favour the occurrence of consumption, will now be noted.

Age.—While the disease may occur at any age, fully one half of the fatal cases are between the ages of 20 and 40. It is less frequent in childhood and in old age.

Occupation.—Persons like knife-grinders, miners, stone-masons, &c., exposed to irritating dust-particles, are frequent victims. The occupation may lead to exposure, to confined habits of living, to loss of exercise, &c., and so favour the occurrence of the disease. Occupations that compel the body to be kept in constrained positions, especially such as hamper the breathing, stooping constantly over a desk, for example, are injurious.

Habits and Mode of Living.—Intemperance and other irregularities of life, and excess of various kinds, by their general effect on the body, are predisposing causes. In a similar way defective nourishment arising from bad or insufficient feeding, or from faulty digestion of one kind or another, has a very powerful influence.

Surroundings.—Breathing an impure atmosphere, such as is common in the small and ill-ventilated homes of the poor, too common also in workrooms of tailors and seamstresses, is a very favourable condition for the development of consumption. A damp soil and a moist atmosphere are also favouring conditions. A variable climate and a cold locality are bad.

Hereditary Influence.—Above and beyond all other predisposing causes is an inherited tendency to the disease. A person may inherit from his parents a weak condition of body which will make him an easy prey to consumption and many other diseases, but he may also inherit a special tendency to consumption in particular. Thus one observer found 75 per cent of consumptive patients belonged to families who had previously been afflicted with the disease. The disease is transmitted more commonly through the mother than through the father, but where one parent only is affected the father transmits it more readily to the sons and the mother to the daughters. Nevertheless it must not be forgotten that an inherited tendency to consumption may disappear under favourable circumstances, and may be greatly aided in disappearing by appropriate means.

In short, a person may *be born with* a delicate constitution and with a strong tendency to the disease; an ordinarily healthy individual may *acquire* a weakened constitution owing to his occupation, surroundings, as a result of various diseases, or owing to the pressure of poverty, anxiety, overwork, &c.; and a person may *acquire* a weakened constitution by his habits, by excesses, undue and prolonged excitements, &c.

Forms of Consumption.—Consumption manifests itself in two forms, the *acute* form, that of **Galloping Consumption**, as it is called, and the *chronic* form. In the former the disease is rapid in its course, ending fatally usually within three months, and sometimes within a few weeks. Sometimes it passes into the chronic form. There have been cases, believed to be galloping consumption, in which a cure was effected. In the chronic cases a common course is for the disease to progress from bad to worse till the patients die of exhaustion in from six to twelve months. But often there are successive attacks followed by apparent recoveries during several years, the disease finally gaining the mastery. Other cases, again, last for years; some ultimately become practically cured. The very varying duration of the disease is shown by the following table, which gives the results of 314 cases:—

24	died	within	3 months.
69	,,	between	3 and 6 months.
69	,,	,,	6 ,, 9 ,,
32	,,	,,	9 ,, 12 ,,
43	,,	,,	1 year and 18 months.
30	,,	,,	18 months and 2 years.
12	,,	,,	2 and 3 years.
11	,,	,,	3 ,, 4 ,,
5	,,	,,	4 ,, 5 ,,
1	,,	,,	5 ,, 6 ,,
3	,,	,,	6 ,, 7 ,,
1	,,	,,	7 ,, 8 ,,
3	,,	,,	8 ,, 10 ,,
11	,,	,,	10 ,, 40 ,,

Symptoms of Galloping Consumption.—It occurs usually in a young person who is suddenly seized with high fever. The pulse is rapid. There is great weakness. The tongue is coated and soon becomes dry, brown in the centre and red at the edges. The lips also become parched and brown, and crusts (called **sordes**) form on them and on the teeth. Looseness of bowels occurs, and often delirium. In many cases it is difficult at first to distinguish between such cases and typhoid fever. Later, cough comes on, and some spit, which may be rusty. The nature of such a case is only revealed by careful and systematic examination of the chest by auscultation and percussion (see p. 266). By this means a skilful physician detects signs of a portion of the lungs becoming solid and then breaking down. The breathing becomes embarrassed more and more, till it is evidenced in the livid hue. The case runs a rapid course, ending in death often in a few weeks by the exhaustion of the patient. Such cases are recognized as due to tubercle. In other forms of the acute variety pain in the chest may be among the first signs, with cough, yellow spit, quick pulse, and fever, which varies in amount, and is accompanied by chills and night-sweats. The signs of destruction of lung-tissue are obtained on examination. Blood-spitting may be the first sign in an attack of acute consumption.

Symptoms of the Chronic forms of Consumption. — The symptoms of the chronic variety are very variable, especially in the early stage, and may develop slowly so as to attract little attention. Cough is usually among the first of them—cough which is at first dry and hacking, apt to be specially troublesome on lying down at night and rising in the morning, and later accompanied by spitting up of clear material—mucus. It is accompanied by weakness which gradually increases, and is attended with loss of flesh. For some time these may be the only symptoms. Gradually the spit becomes more or less yellowish, being mixed with matter (pus). The digestive organs are frequently disturbed. Careful examination in the early stage will often show that the temperature rises above the usual in the afternoon and is below it in the morning, and that the breathing is faster than usual and the pulse quickened. Examination of the lung may detect alterations in the breath sounds (p. 266), but these it is useless to specify here. Very commonly the patient does not complain of shortness of breath till great alterations have taken place in the lungs, so stealthily do they develop. In the later stages there are increase of cough and yellowish spit, and, as the disease becomes confirmed, feverish attacks are marked, becoming of the hectic character—that is, the fever is preceded by a chilly sensation and followed by copious sweats. The fever causes a brilliant spot on the cheeks—the hectic flush. A tendency to night sweats is not infrequent in the early stage, but in the later stages they form a very prominent and exhausting feature of the disease. Examination of the lungs in the later stages gives evidence of advanced breaking down of the lung-tissue and probably of the formation of cavities. The chief symptoms then are cough, spit, increasing exhaustion and loss of flesh, feverish attacks and night-sweats. The disease may begin by blood-spitting, which may come up with the spit, streaking it, or in quantities at a time; and loss of blood in this way frequently occurs during the progress of the disease, aggravating the condition by the weakness it induces. Moreover, consumption may slowly and insensibly arise from chronic bronchitis and other lung affections.

In the progress of the disease other symptoms indicate that various other organs are affected. Notably in advanced phthisis is looseness of the bowels common. In some cases it is most intractable, increasing the exhaustion of the patient with great rapidity, being due to deposit of tuberculous matter in the bowels; and it may be accompanied by pain in the belly.

Fistula in the anus (p. 194) is frequent in consumptive patients, and the healing of the fistula has, in many cases, been followed by rapid progress of the disease. On this account, though it is curable by a surgical operation, many, who fear consumption, prefer to leave it alone.

In some instances alterations of voice, hoarseness or loss of voice, are the first signs of the growing disease. Sometimes they are due to tubercular ulceration in the larynx. Whether this is the cause can be determined by an examination with the laryngoscope (p. 263).

Confirmed consumptive patients may be known by certain curious physical characters: clubbed form of the ends of the fingers and the nails, pearly-white colour of the white of the eye, wide condition of the pupil (the black of the eye), and the presence of a reddish or purplish line along the junction of the gums and teeth.

Death is due commonly to exhaustion, but may occur suddenly owing to great loss of blood

by the lungs, or may be caused by some complication. Dropsy, occurring usually in the feet and legs, and the presence of thrush in the mouth are signs of the approach of the end.

Treatment.—The general treatment of consumption is plainly indicated. Everything that can aid in maintaining and increasing the person's health must be rendered available. The meals should consist of a nourishing diet, of an easily digested kind, and should be at regular and stated intervals. The diet should be generous rather than restricted. The digestive powers are often weak, and the stomach and bowels disordered. They may be aided by the use of tonics, the iron, quinine, and strychnine tonic, or the acid tonic (see PRESCRIPTIONS), and the movement of the bowels should be as regular as possible. The functions of the skin ought to be attended to. For this purpose daily sponging with tepid water of the surface of the body, and especially of the chest and back, followed by brisk rubbing, is very valuable. Woollen underclothing should always be worn.

Regular gentle exercise should be engaged in, as much time being spent in the open air as the person's health will permit. Gentle gymnastic exercise of the sort to expand the chest is useful if carefully employed. The consumptive must be surrounded by healthy conditions, pure air being essential, as large, airy, and well-ventilated a house, as circumstances will permit, being selected for residence, kept at a regular temperature, and free from draughts. Special attention should be given that the sleeping apartment has a free circulation of pure air, but is also free from draughts. The house should be in a dry and sheltered situation, built on sand or gravel, and well drained. The person's own habits should be well regulated. Early hours should be indulged in, though a due amount of sleep ought always to be obtained; fatigue is to be avoided and excitement; excessive work, physical or mental, and worry, being very depressing, are very injurious. The sort of climate that suits the consumptive is that which is dry, mild, and not liable to sudden variations. In England Hastings, Ventnor in the Isle of Wight, and Torquay, are favourite places, the south of Spain, Madeira, and the Riviera, on the continent of Europe, and Egypt and South Africa. Sea voyages to Australia or New Zealand are of great value, and the Andes, Rocky Mountains, and Alps are much frequented by consumptives. Of course on a patient's health and ability to travel depends largely the choice of a climate. High altitudes are now much sought after, Davos among the Alps being a favourite place for English patients.

The main medicinal treatment of consumption consists in the administration of cod-liver oil. It is of course in the early stage that it is most useful, and then when given regularly for a long time its effects are often marvellously beneficial. Under its use the patient frequently gains flesh and strength, and cough and spit are diminished. It should be given in small doses at first, of one tea-spoonful or so, twice daily, till the person gets used to it, when it is gradually increased till three table-spoonfuls are taken daily. It seems to agree best when taken shortly after meals and before going to bed. To disguise its taste it may be given in milk, butter-milk, claret, or in any other way the patient likes. Exercise in the open air greatly aids its digestion. There are not very many people who, by various devices, cannot be gradually accustomed to its use. With a few, however, nothing can make it agree. For them cream, glycerine, or fat of meat—such as fat bacon—may be tried instead, or some of the various preparations of malt extract. Iron tonics and quinine are also administered with benefit in consumption.

As to special treatment for various circumstances it is doubtful whether it would be of much service to note it in a work like this. To direct treatment beyond what has been described would be too much responsibility for any but a medical attendant. For example, blisters are often valuable for relieving pain and for checking inflammation going on in the lungs. For the relief of constant and harassing cough the administration of opium in some form or another is always a necessity, and for the checking of exhausting night sweats belladonna is one of the most useful of drugs. But whether or not a blister should be applied, and where it should be applied, what form of opium should be given, and how much, what dose of belladonna and so forth, are questions to be answered in each case according to the circumstances. In the unavoidable absence of a medical attendant 5 to 15 drops of laudanum may be cautiously ventured on twice or thrice daily if really necessary. If the cough seems to be due to difficulty of getting up the spit, 20 to 30 drops of ipecacuanha wine with syrup of squills will help in its removal. To check sweating a pill of ¼ to 1 grain of belladonna is given at bed-time, and the patient's body should be sponged once or twice daily with vinegar and tepid water (twice as much water being used as of vinegar). The

checking of looseness of the bowels is often a most difficult thing to effect. One of the best preparations consists of from 5 to 10 grains of Dover's powder with 10 grains of bismuth added. Dilute sulphuric acid (10 to 15 drops in water) sometimes relieves. To control bleeding from the lungs 10-grain doses of gallic acid at intervals of three hours are useful. Liquid extract of spurred rye (*Secalis cornutum*) is most efficient for this purpose, of which from ½ to 1 teaspoonful in water is given at a time, and repeated every two or three hours as long as necessary. The active principle of the drug, ergotine, may now be had in pill. Its dose is 3 to 5 grains, and it may be used instead of the liquid extract. A patient who has had copious bleeding from the lung should be kept quiet, lying in bed with head high in a cool room, and small pieces of ice may be given to suck.

The Prevention of Consumption.—It should not be forgotten that for those who are delicate and suspected of a consumptive tendency much may be done to ward off the disease. It ought never to be taken for granted that a person is bound to be a victim of consumption either because of the state of health of the individual or because of the family tendency. On the contrary many persons have been saved from such a fate by such attention and care as have been recommended in the early paragraphs on treatment, who otherwise would have had little chance of escape. Such measures as have been urged ought to be rigidly carried out. *Ordinary colds ought never to be neglected*, and if cough, &c., threaten to remain change of air should be tried without delay. Mothers who, because of family tendencies, fear for their children are apt, in their anxiety, to do the very things that are most hurtful. They smother them up with clothes, and so hamper them in this way that all their healthy movements are restricted, those of the respiratory organs among the number. They keep them confined to hot rooms, and restrict their out-of-door exercise, and when the children are allowed out they are cumbered with so many wraps that walking is a labour; the children become hot and covered with perspiration, and wish to sit down on every odd door-step or other equally cold resting-place. Such measures as these are the grossest possible mistake, for, instead of warding off the threatened danger, they directly invite it. Abundance of fresh air is an essential in the prevention of consumption, and regular systematic exercise of the body, particularly of the chest muscles, is another. The child who is confined to warm rooms or kitchen, and whose bodily temperature is artificially maintained instead of by its own activity, is unable to resist the influence of the slightest breeze. It is a hot-house plant that will be speedily blighted when brought into the open air. But it was made for the open air and not for the hot-house, and it is the ignorance or stupidity (let the proper terms be applied, though they are strong) of mother, nurse, or guardian, that has overturned the design of nature, and substituted sickliness and weakness for health and vigour. There is, however, the other extreme, equally at variance with sense and fact as the former, the extreme of which parents and guardians are guilty who adopt what is called "the hardening process." They expose their children to all sorts of weather improperly protected; they treat them to daily cold shower-baths as a matter of routine, and so on, in the expectation that they will become used to and unaffected by exposure. The only proper course is for children to be clothed so that no healthy movement is restricted, and so that a regular and moderate degree of warmth is maintained. Plenty of exercise in the open air should be allowed; but excessive exercise, that throws the child into perspiration and leads it to sit down to cool, is to be cautioned against. In warm weather the clothing should be lighter to counterbalance it, and in colder weather heavier, both extremes being avoided in which the child is either never warm unless romping or always so warm as never to be able to romp.

The preventive treatment for adults is such as has already been described under general treatment.

Spitting of Blood (*Hæmoptysis, Bleeding from the Lungs*) is to be carefully distinguished from vomiting of blood, in which case the blood comes from the stomach, is commonly dark from contact with the acid juice of the stomach, and is mixed with the contents of the stomach. In hæmoptysis the blood comes from the lungs or air-passages in them, and is expelled by coughing. It may be present in the spit merely as spots or streaks, or uniformly colour the spit, or it may come in clots, or in gushes of bright blood, frothy because mixed with air. Where it rushes out in quantity no effort at coughing may exist, or there may be but a slight cough. It must be observed that streaks of blood may be present in the spit and not come from the lungs at all, but from the back part of the nostrils or the pharynx, and may, consequently, mean little or nothing. Further, bleeding may take place

from the nostrils so far back that the blood finds its way into the back of the throat, and is expelled by a very slight effort. The true nature of such cases will be revealed by an examination of the back of the throat with a strong light, when a fine line of blood is likely to be observed down the back wall of the pharynx from above.

Bleeding from the lungs may be the result of many varied diseases, such as congestion, inflammation, or ulceration. It may be apparently the first occurrence in an attack of consumption. Persons may be repeatedly attacked with hæmorrhage from the lung and no special sign of lung disease be discovered. The bleeding may return at intervals, and consumptive disease not show itself for years. At the same time consumption may speedily follow the first attack. Bleeding is also a frequent occurrence in the progress of consumption, vessels being opened into by the destructive process. In pneumonia (p. 274) loss of blood from the congested vessels gives the rusty appearance to the spit, and in bronchitis streaks of blood in the spit are not uncommon. The bursting of an aneurism (p. 244) into the lungs, or one of the bronchial tubes, will occasion profuse bleeding, the patient dying speedily. Cancer also causes bleeding.

Where the loss of blood is considerable the nervous shock to the patient is usually great.

Treatment.—A person who has suddenly coughed up a considerable quantity of blood should be put to bed, the shoulders being raised. The room should be cool and perfectly quiet. Ice in small pieces given for sucking aids in checking the bleeding. The best medicines are dilute sulphuric acid (30 drops every three hours) in water, gallic acid 10 grains, every two or three hours as long as necessary, or ergotine 3 to 5 grains repeated as required, or ½ to 1 tea-spoonful of liquid extract of ergot instead.

Stimulants are not, as a rule, advisable, tending, as they do, to excite the heart, and so increase the bleeding. Food should be given *cold* for some time after the bleeding has ceased.

If the attack comes as a surprise to the patient, who has seemed a moderately healthy person, it should induce him or her to have a careful examination made of the lungs and heart specially, and its warning should not be disregarded.

Dilatation and Collapse of the Lungs.

Dilatation or Emphysema (from Greek *emphusao*, to dilate) is a condition of all or parts of the lungs in which the air-cells are larger than usual, being greatly distended. The walls of the air-cells have lost their elasticity, so that they cannot recover from undue stretching. The condition is the result of some excessive pressure exerted on the walls of the cells by the air within them. It is a common consequence of blocking up of parts of the lung. If the chest enlarges as usual the parts of the lungs that have become blocked up cannot receive any of the entering air, and the healthy parts must consequently stretch to make room for it. If the unusual state continues for any time, the permanent overstretching of the walls of the air-cells destroys their elasticity, so that, if they had the opportunity, they could not recover themselves. It is a consequence of bronchitis, of blocking up or destruction of parts of the lungs, and of other diseases. It may be originated by constant playing of wind-instruments, and by the efforts to raise heavy weights. Though a disease of adults, children affected with croup, hooping-cough, &c., are liable to it.

Its **symptoms** it is needless to discuss, the chief being shortness of breath. It develops a barrel-shaped chest.

Its **treatment** is mainly such as will tend to support and nourish the body, improve the general health and condition of the blood. Nourishing food, and attention to the bowels are thus of the utmost importance, and to these is added the administration of iron tonics and cod-liver oil.

Collapse of the Lungs (*Atelectasis*, Greek *atelēs*, imperfect, and *ektasis*, widening).—The air-cells are empty of air and their walls collapsed, so that the part of the lung affected is more or less shrunk and solid. This may be effected by pressure, for instance by the pressure of a great quantity of fluid in the pleura as in pleurisy (p. 266). It may be present in bronchitis and other diseases of the lungs owing to plugs of matter occupying bronchial tubes and acting like ball-valves, permitting air to leave the part of the lung which the tubes supply, but none to enter. Children during the first year of life, especially the weakly and ill nourished, are specially apt to suffer from this affection in the progress of measles, hooping-cough, or croup. Atelectasis is the term applied to the condition of the lungs of children who have not breathed after birth—the air has not entered to expand the air-cells.

The detection and treatment of the condition are the work of a physician.

Tumours.

Tumours of various kinds have been found in the lungs. **Cancers** and other malignant growths are not uncommon, leading to destruction of lung tissue, and sometimes eating into blood-vessels, causing death by bleeding.

Injury of the Lungs.

The lungs are sometimes implicated in wounds of the chest. A fractured rib, for example, may wound the lung and cause spitting of blood. In such cases bandaging the chest to prevent movement of the injured part, or the treatment by strips of plaster as recommended for broken ribs (p. 48) is desirable. Difficulty of breathing, spitting of florid and frothy blood, are among the symptoms that indicate the affection of the lungs. The patient should be kept quiet, propped up in a half-sitting position, and remedies noted under HÆMOPTYSIS (p. 282) should be used.

SPECIAL SYMPTOMS CONNECTED WITH AFFECTIONS OF THE LUNGS AND AIR-TUBES.

Cough is a symptom of many different affections, and its treatment depends on its cause. It consists of a deep breath followed by closure of the glottis, and a series of rapid expiratory efforts. It is the result of a nervous action originating in an irritation of the ends of sensory nerves distributed to the inner surface of the larynx. The impression is conveyed to the centre for breathing in the medulla (p. 93), and from thence messages pass to the muscles of respiration and to those of the glottis, by which the cough is produced. The irritation which begins the process may be owing merely to cold air entering the larynx and passing over an inflamed surface. It may be that the surface is not inflamed, but that the indrawn air contains irritating particles. Again it may be caused by the tickling of some phlegm poured out by an inflamed membrane, or of some matter swept up from the lungs. It may also be a mere nervous affection, or due to some condition of the blood, as in gout and rheumatism, or the nervous irritation may arise from disordered stomach or liver. The cough is thus either dry, that is, unaccompanied by spit, or moist when it is so accompanied. It varies in character. It is spasmodic in hooping-cough and croup. The "hoop" which attends the former readily distinguishes it, and the loud brassy sound of the latter is characteristic. In cough from obstruction of the air-passages arising, for example, from an inflamed and swollen lining membrane, such as common cold produces, it is also spasmodic and wheezy. Where the vocal cords are rough by the swelling it is harsh, barking, and hoarse, and when the cords are covered with membrane, as in diphtheria, it is wheezy and voiceless.

The **treatment** depends so entirely on the cause that it is impossible to give any special treatment for the mere symptom. It may be noted, however, that one of the commonest and most troublesome coughs attends slight cold from swelling and irritability about the larynx. Warm poultices over the front of the neck greatly soothe and relieve it. If that fail, a piece of flannel sprinkled with turpentine, or with soap and opium liniment, should be placed directly over the larynx on the neck. If a mustard poultice be used, and it is often very efficient, it should be placed lower down at the top of the breast-bone. A cough, due to this affection, is usually dry, and if obstinate, great pain is experienced in a line across the front of the chest, the line of the diaphragm (p. 253), occasioned by the severe and constant spasmodic movement of the chief muscle of breathing. Other drugs failing, a dose of 15 to 20 drops of laudanum (*only to adults*) will stop it more or less for a time. This, however, would be the worst possible thing to give, were the cough attended with much spit, as in bronchitis, inflammation of the lung, &c. It is the matter coming up from the lung that is the irritating agent in such cases. Laudanum and other similar soothing drugs would simply blunt the nerves to the presence of the matter, which would not be expelled, but be allowed to remain in the tubes, and might by blocking them seriously aggravate the state of the patient. In such cases what is desired is to aid in the expulsion of the matter without serious efforts of coughing. For this purpose warm applications to chest and throat are valuable, and drugs like ipecacuanha wine (10 to 30 drops) and syrup of squills.

A very intractable form of cough is produced by relaxed throat and elongated uvula. The long uvula touches the tongue and maintains a constant tickling. The sprays recommended for clergyman's sore throat (p. 287) are useful here. The best treatment, however, is to snip off a piece of the too long uvula with scissors, which occasionally causes the cough to stop as if by magic.

Difficulty of Breathing (*Dyspnœa*, Greek *dus*, difficulty, and *pneo*, to breathe).—Difficulty

of breathing attends many affections of respiratory organs, and occurs in very varied degree. It may amount to mere increased rapidity of breathing and shortness of breath on the slightest exertion, owing to general feebleness, as in anæmia, or to disease of the heart, or chronic disease of the lung, and may produce little discomfort. More than this it may be, up to that degree in which breathing is a constant struggle, agonizing almost in its character, when every muscle that can possibly aid in drawing air into the lungs is called into play, nostrils working, muscles of neck straining, and chest heaving, the lower part being frequently sucked in. In children the movement of the nostrils is often the first indication of some interference with easy breathing, and later excessive heaving of the belly and sucking in of the lower ribs become marked. Accompanying the severe forms of dyspnœa are indications of the want of proper aëration of the blood, lividity of the surface of the body, blueness of finger nails, coldness of the extremities; and when the struggle is severe the perspiration stands in beads or streams down the face. When the difficulty is considerable and lasting, without being so extreme, the want of proper purification of the blood produces headache, languor, and dulness. In asthma (p. 273) the difficulty of breathing comes on in spasms, is often excessively severe, seeming to threaten suffocation, and gradually passes off after a time.

Dyspnœa is of various kinds. Sometimes it is due to obstruction in the air passages because of swelling, the formation of false membranes, dropsy of the larynx (p. 270), the presence of foreign bodies or tumours, or accumulation of secretion, as in bronchitis, or blocking of the lungs, as in pneumonia (p. 274) and consumption, &c. It is a common symptom of valvular disease of the heart (p. 239). It may be of nervous origin, as in asthma; and it must not be forgotten that it may be associated with a cause quite outside of the chest, owing, for instance, to tumours or accumulated fluid in the belly pressing up the diaphragm (p. 253), and thus interfering with expansion of the chest. In this way an overloaded stomach or a congested liver will cause shortness of breath.

Suffocation (*Asphyxia*, Greek *asphuxia*, a stopping of the pulse) is an advanced stage of dyspnœa. It is the result of want of oxygen in the blood. Usually this want is the result of the exchange between the gases of the blood and those of the external air (p. 260) being interfered with, so that not only does the deficiency of oxygen become marked, but there is an accumulation of carbonic acid gas in the blood. Excess of the latter gas in the blood would not, however, produce suffocation, provided sufficient oxygen were at the same time supplied; but it would produce the signs of narcotic poisoning, namely, profound sleep, and complete insensibility that might end in death. It is the lack of oxygen that produces the results to be described.

It is evident that asphyxia may be brought on in two ways: (1) either by the person being in an atmosphere incapable of supplying anything like the due amount of oxygen, or (2) while the atmosphere is of a proper kind some obstacle exists to the admission of the air to the blood. The latter event may happen because the air cannot be introduced to the lungs because of paralysis of the respiratory movements, because the lungs have become blocked up and cannot admit it, or because some obstruction exists in the air passages. Thus some foreign body may have fallen into the windpipe, or the windpipe may be closed by strangulation, or the chest may be prevented moving, as, for instance, happens when a mass of earth falls upon a person burying him up to the neck.

Asphyxia may occur suddenly by sudden complete interruption to the breathing, or may come on more slowly, as it does in some diseases, difficulty of breathing becoming worse and worse till it passes into a state of suffocation. However it occurs its symptoms are the same.

Symptoms.—Three stages are recognized in the progress of the process of suffocation. In the *first stage* there is great difficulty of breathing, in which every muscle is exerted in the effort to get air into the lungs, the veins of the surface of the body becoming distended and livid. This laboured breathing passes into general convulsions, in which nearly all the muscles of the body partake, the fæces and urine being passed by the convulsive movements. Then follows the *second stage*, in which the animal or person lies quiet and insensible, the pupils being widely dilated, the muscles all relaxed, and no movement is capable of being called forth. Following this is the *third and final stage*, when long and slow efforts to breathe in are made at long intervals, and become gradually like convulsive gasps, until with one final gasp, head being thrown back, back arched, nostrils dilated, and mouth widely open, death occurs. The heart ceases only after all other movements have stopped. If the obstruction

to the breathing be sudden and complete the stages are all passed through in the course of three to five minutes, and the heart stops in between seven and eight minutes after deprivation of air. In experiments performed to ascertain after what lapse of time recovery could occur, it was found that a dog, simply deprived of air for four minutes, recovered; but if deprived of air by submersion in water, recovery was impossible after one and a half minutes, apparently because the entrance of water had prevented the restoration of the lung's function.

Treatment of suffocation consists in removing, if possible, any obstacle to the entrance of air. If that has been accomplished the next thing is to cause air to enter the chest. When the case has not gone too far, movements of respiration may be excited by dashing cold water over the chest, or by lashing the chest with towels dipped in cold water. If no movements can be excited in this way air can still be caused to enter the lungs by artificial respiration (see ACCIDENTS AND EMERGENCIES). Sometimes breathing can be induced by electric shocks properly applied to the nerves of breathing. Recovery need not be despaired of unless the heart has ceased to beat.

Apnœa (Greek *a*, not, and *pneo*, I breathe), cessation of breathing, is sometimes used to mean asphyxia. Really it means stoppage of breathing, because of *excess* of oxygen in the blood, not because of deficiency. Let any one take quickly a series of deep breaths. The desire for breathing will pass away for a little, and a slight interval will elapse before it returns. The first few breaths after the interval will be feeble and shallow. The condition of apnœa has been produced.

Lividity (*Cyanosis* (Greek *kuanos*, blue), *Blue Disease*) is only a symptom, and indicates want of proper aëration of the blood. If the blood has not its due supply of oxygen it becomes of a dark hue, and still more dark if it contains an excess of carbonic acid gas (p. 216). In such circumstances the purplish blood will give a livid hue to the skin instead of the ruddy colour of health, and the livid colour is most quickly seen in the lips, tongue, and under the finger nails, though in marked cases the whole skin exhibits the dusky colour. Any disease of the lung interfering with the due interchange of gases (p. 258) tends to produce it. It is most marked in a defective condition of the heart, dating from birth, owing to which impure blood from the right side is permitted to pass directly to the left side without previously passing through the lungs. It is of course a conspicuous symptom of suffocation.

AFFECTIONS OF VOICE AND SPEECH.

The voice may be affected in various ways. It may be weakened, that is, its *force* diminished, by any disease which reduces the general strength, or the extent of the movements of the vocal cords may be voluntarily lessened because of pain any vigorous movement would call forth. Its *pitch* is variously affected, not only by the condition of the cords themselves, but also by the state of the air-tubes above them. The cords may be thickened by swelling, the result of catarrh, or the mucous membrane may be relaxed, so that the usual rapidity of vibration or stretching of the cords cannot be produced, and the pitch will be lowered. But the larynx and throat may be similarly thickened and relaxed so as to be unable to resound to sounds of the same pitch as formerly. Singers and public speakers ought to observe that enlarged tonsils (p. 156) act in this way, and markedly lower the pitch of the singing voice, or cause a painful sense of straining when singing or speaking for any time. Some celebrated singers, who have had enlarged tonsils removed, found with delight that after the operation they were capable of taking notes fully half an octave higher than formerly. The *quality* of voice is also affected in various ways, the most marked alteration being when hoarseness or huskiness is produced.

Hoarseness is due to irregular and imperfect bringing together of the vocal cords, and is most frequently due to swelling of the mucous membrane of the cords, to thickening, and to excessive secretion of mucus in their neighbourhood, such as common cold will readily induce. Various other reasons may exist to account for it, such as inflammation, ulceration, contraction, &c., of the cords or in their immediate neighbourhood. Most obstinate hoarseness is produced by syphilitic thickening and ulceration, and by tubercular ulceration, such as often occurs in the progress of consumption. Paralysis of the cords, owing to pressure on the nerves supplying the muscles of voice, or other nervous disease, is also a cause.

Treatment, to be of value, must have regard to the condition of the cords and larynx, and the condition can only be properly ascertained by examination with the laryngoscope (p. 263). The hoarseness that comes on quickly with pain on

any attempt to speak, as a result of ordinary cold, should be treated with soothing remedies, the inhalation of the steam of boiling water, warm poultices to the neck, &c. Later, when all pain has passed away, and only the hoarseness remains, the sprays recommended for clergyman's sore throat are useful.

Clergyman's Sore Throat (*Dysphonia clericorum*).—This is an affection to which not clergymen only, but teachers, lecturers, and all public speakers generally are liable. It consists of a chronic thickening of the mucous membrane of the throat and larynx. The membrane is thickened and relaxed, and pours out an excessive quantity of thickened mucus which is brought away with difficulty. There is a feeling of great discomfort in the throat, especially after speaking. The person feels as if a veil had been drawn over his speaking apparatus, as if something were present which by coughing or hawking he could dislodge, and he dislodges it only to find it again collect. It is the mucus that gives this impression.

Treatment is difficult, since the chief element in the best would be absolute rest for some time, and that is generally impossible. The person should always try to avoid straining the voice, and specially if he is affected with the slightest cold, as loss of voice lasting for some days might thereby quickly arise. His general health should be maintained as well as possible by stomach, bowels, skin, and kidneys being kept in good order, and by the use of some tonic medicine such as quinine and iron, or phosphorus quinine and iron (p. 113) if necessary. For the throat local applications are needful. Weak alum or chlorate of potash gargles are useful (see PRESCRIPTIONS); but these never get down to the vocal cords. For the medicine to reach the cords it must be drawn in with the breath in the form of spray. To effect this atomizers or spray producers (see MEDICAL AND SURGICAL APPLIANCES) are employed, by which the liquid is dispersed in a cloud of small particles by a strong current of air. The point of the atomizer is held within a few inches of the mouth. The mouth is widely opened, the tongue being kept down as much as the person can, and when a full stream of spray is directed into the mouth the person draws a long deep breath and thereby introduces the material into the larynx and windpipe. Various drugs may be used, of various strengths, with the spray producer. In the appendix on PRESCRIPTIONS—GARGLES, &c., some are mentioned. A useful one consists of tincture of steel, 2 fluid drachms, glycerine, ½ ounce, rose water, 1½ ounces, and water to 4 ounces. This is put into the bottle of the atomizer full strength or diluted with water if necessary. If required it may be made stronger by the addition of one or more drachms of the tincture of steel.

In very troublesome cases, however, nothing equals the direct application of some solution to the vocal cords and affected parts by means of a brush. This only an experienced and dexterous surgeon can accomplish properly.

Loss of Voice (*Aphonia*, Greek *a*, not, and *phōnē*, the voice) sometimes is the result of severe cold; ulceration and other changes of the vocal cords cause it. Paralysis of the cords makes it complete, and the paralysis is not infrequently the result of the nerves of voice being involved in some growth or pressed upon by a tumour, aneurism, &c. In women loss of voice without any structural changes is frequent, being due to hysteria or other nervous condition. Nervous women, plagued with uterine troubles, are subject to it, and the loss of voice is not permanent but temporary, relapses being common. Cases are on record where no word was spoken for months or years, hysteria only being the cause.

Treatment it is needless to specify particularly, considering the necessity of some one being consulted who can determine the exact cause. In loss of voice from cold, however, warm applications to the neck, a blister over the top of the breast-bone, inhalation of steam, &c., are useful.

The Care of the Voice deserves a word. Anyone who reads the description of the vocal apparatus on pp. 261, 262 will understand how exquisite are the adjustments of the various parts for even ordinary speaking, and how the slightest alteration in the proportions of parts by cold, swelling, &c., will seriously affect the whole instrument. It should, therefore, be evident that anything that overstrains the parts, too prolonged use of the voice, talking or singing in too high a key, screaming, &c., must have a bad effect on the vocal instrument; and that such overstraining will be most easily accomplished when the person is fatigued, in indifferent health, ill-nourished, or when the parts are affected by cold, &c. Therefore, wherever possible, in such circumstances, the voice should not be used at all. Most people become impatient at the excuse of those who can sing,

when a slight cold is offered as a reason for refusing to comply with a request or to fulfil an engagement, but it ought not to be so. A cold not perceptible to anyone is yet sufficient reason for the singer refusing to exercise his or her gift. Indeed the singer who had not such regard for his or her voice would speedily have little voice worth regarding. Singers and public speakers ought also to pay attention to the condition of tonsils, &c., as they, if enlarged, materially affect the pitch and quality of the voice.

Stammering or Stuttering implies usually a sudden check to the utterance of words followed by a longer or shorter pause, during which the person makes sundry attempts to utter the word at which he was stopped. It is a spasmodic affection, and it occurs most commonly in the utterance of the consonantal sounds p, b, t, d, g, and k, though also with s, z, sh, m, n, v, y, w, f, and more rarely with vowel sounds. As a rule persons do not stammer when whispering or singing. It does not seem to depend on any organic defect, but partakes more of a nervous affection, the complex series of muscular movements involved in speech not being properly subordinated to one another and controlled.

It is a defect which shows itself between the age of four or five and puberty, and may come on as the result of feeble health after illness, or owing to fright or excitement, and *sometimes by imitation.*

Its **treatment** consists of careful, patient, and determined training. The stammerer must be taught to speak slowly and deliberately, must practise the sounds at which he stammers, and must learn to restrain all tendency to become excited and hurried when nearing the sound which presents difficulties. Practising reading aloud in the presence of some one who will check at once any departure from slowness and deliberateness of utterance is one of the best possible aids. The stammerer has also to train himself to regulate the movements of his breathing, as the tendency is to run on until a stop for want of breath is necessary. It is only by such careful and long-continued training that the defect can be remedied.

Section X.—THE KIDNEYS AND BLADDER.

A. THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Kidneys: *Their structure*—tubuli uriniferi—Malpighian bodies or glomeruli;
Their functions—the formation of the urine;
The excretion of the kidneys—the urine—its characters and chemical constitution—urea—unusual constituents (albumen, sugar, bile, blood).

The Ureters and Bladder:
The Ureters;
The Bladder—its structure and functions—the mechanism of the expulsion of urine.

In the previous section the method by which the blood is purified to the extent of being deprived of its excess of carbonic acid gas, through the agency of the lungs, is described. But carbonic acid gas is not the only waste substance derived by the blood from the tissues. There are others, as important, the result of the decomposition in the body of nitrogenous or proteid (p. 132) substances. If they are allowed to remain in the body death is the result. To separate these nitrogenous waste substances there must be some special apparatus. That special apparatus is found in the kidneys and their attendant organs, urinary bladder, &c. They are, therefore, exclusively excretory organs—organs solely devoted to the purpose of separating from the blood substances to be expelled from the body. The substances are separated in a liquid form, the urine; and as the urine is formed slowly, after passing from the kidney it is collected in a reservoir—the bladder—until some quantity has accumulated, when it is discharged by a voluntary effort.

THE KIDNEYS.

Their Structure.—The kidneys are two in number, and are situated in the cavity of the belly, one on each side of the back-bone, between the eleventh rib and the crest of the haunch-bone. The liver is above the right kidney, the spleen (p. 204) above the left; while

both lie close against the back wall of the belly, so that the intestinal canal is in front of them. The human kidney is about 4 inches long, 2 inches broad, and 1 inch thick, and weighs usually about $5\frac{1}{2}$ ounces. The shape of the human kidney is the same as that of a sheep, or rabbit, and is well known. The connections of the kidney are shown in Fig. 137, which represents the outline of the belly, opened, the intestinal canal being removed. A kidney appears on each side of the back-bone, blood-vessels being connected with each, and from each a tube—the **ureter**—passes downwards to the bladder, situated in the cavity of the pelvis.

If a kidney be cut open in the direction of its length an appearance exhibited in Fig. 138 is seen. The ureter (U) where it joins the kidney expands into a wide cavity (P), which is called the **pelvis** of the kidney. Into the pelvis conical processes of the fleshy substance of the kidney project. The processes are called pyramids, or the **pyramids of Malpighi**, after the anatomist who described them, and in the human kidney there are about twelve of them. The point of each pyramid is invested by a part in continuation of the pelvis, which surrounds it like a cup or calyx. Now the fleshy-looking substance of the kidney consists of very fine

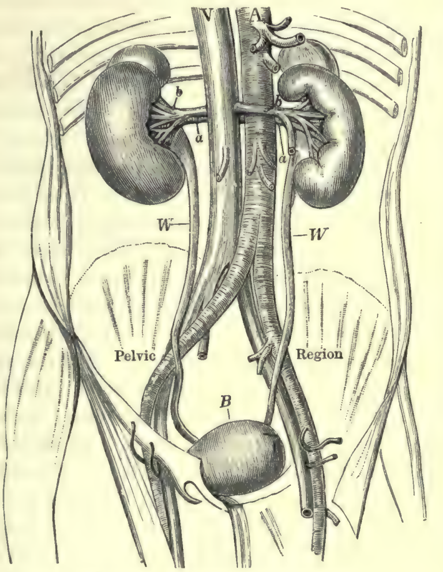

Fig. 137.—The Situation of the Kidneys.

A, Aorta; V, Vena Cava; B, Bladder; W, Ureters. Branches of the aorta (*a a*) are seen going to the kidney, and veins from it (*b b*) are shown joining the vena cava.

tubes, the **tubuli uriniferi** (or urine-carrying tubules). Towards the surface of the kidney the tubules run a very irregular course, but towards the centre they run a straight course. The distinction between the part of the kidney containing the twisted tubes and that contain-

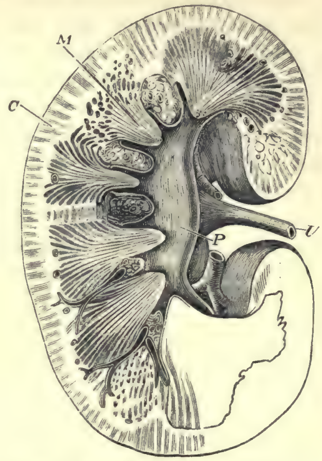

Fig. 138.—A Kidney opened in its length.

C, Cortical portion; M, Medullary portion; P, Pelvis; U, Ureter.

ing the straight tubes is easily made out with the naked eye, the former part appearing granular, and being called the **cortex** or rind, while the central parts appear streaked, and are called the **medulla**, or marrow-like. The distinction is represented in Fig. 138, where it is evident that the medullary portion is formed of the pyramids whose bases rest on the cortex.

It is in the tubules that the urine is formed. The tubules all ultimately open by a group of mouths on the surface of the pyramids, so that the urine formed in them finds its way into the pelvis of the kidney, and thence down the ureter into the bladder.

The **tubuli uriniferi**, of which the bulk of the substance of the tissue is made up, are very fine tubes, about the $\frac{1}{600}$th of an inch in diameter. They run a very irregular course, undergoing various changes in different stages. They begin in the cortical or outer portion of the kidney in a blind extremity which is widened into a pouch or capsule. Into the capsule, as will be noted hereafter, a bundle of capillary blood-vessels projects. From this expanded extremity the tubule passes off by a narrow neck, and winds a very irregular course in the cortex, twisting and turning upon itself for some distance. This part of the tubule is called the **convoluted tubule**. Then, after a short portion in which the tube is more spiral than twisted, it suddenly contracts to a very narrow diameter and courses straight on towards the central or medullary part of the kidney into

which it enters. But shortly after entering the medullary region it turns upon itself and proceeds, still in a more or less straight direction, and as a very narrow tube, back into the cortex. This narrower portion that doubles on itself is called the **looped tubule** of Henle, after the observer who first described it. Ultimately the tubule mingles again with the convoluted tubules, and again becomes itself wider and wavy or spiral. This second spiral part of the tube leads into a wider straight tube which passes down through the cortex to the medulla. As it proceeds through the medulla it joins, now and again, similar tubes at

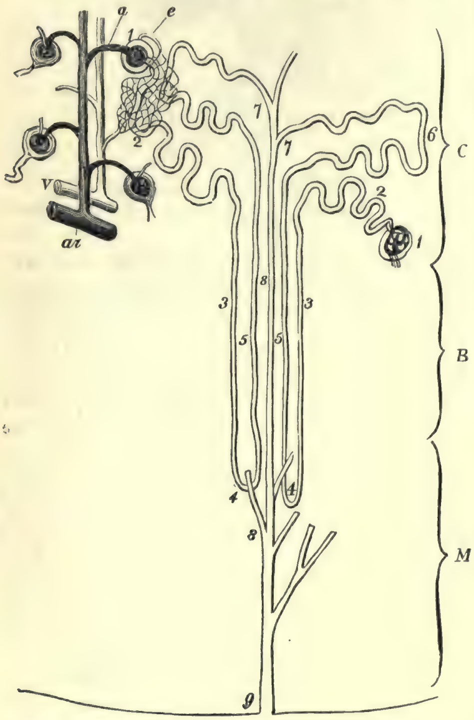

Fig. 139.—Representation of the Tubules and Blood-vessels of the Kidney.

On the right-hand side 1 points to the widened end of a tubule (in the cortex) containing a tuft of blood-vessels. The tubule passes off as the convoluted tubule (2), then it suddenly becomes straight (3) and passes down to the medullary region, turning back at 4 and passing back (5) to the cortex, where it becomes wavy (6), and ultimately joins a straight tubule 7, running downwards (8, 8) through the medulla to open at 9 on the point of a pyramid into the pelvis of the kidney (see Fig. 138). On the left-hand side of the figure the relation of tubule and vessels is shown: *ar* is a branch of the renal artery, from which a twig (*a*) passes off to enter the widened end of a tubule; *e* points to the vessel leaving the tubule and breaking into a meshwork of capillaries, which finally form again into one vessel, joining a branch of the renal vein (V). The artery is shown giving off other twigs to other tubules. At the side, C indicates the cortical region, M, the medullary region, and B, the layer bounding the two.

acute angles or is joined by them, becoming thereby gradually wider until it opens on the surface of a pyramid. Fig. 139 gives a view of the passage of a tubule from its expanded extremity in the cortex to its mouth on the point of a pyramid.

In the different parts of their course different

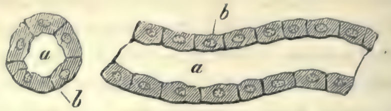

Fig. 140.—Very highly magnified view of section of a tubule, cut across and in its length. *b*, cells; *a*, channel of a tubule.

diameters of the tubule have been noticed, and there are other corresponding differences. The tubules are formed of a delicate membrane whose inner surface is lined with cells. In some parts of the tube the cells are large and cloudy, presenting the appearance of cells engaged in the active work of secretion. In other parts they are small and insignificant, evidently not for secreting purposes, but simply to act as a lining to the tube. Fig. 140 shows the appearance of a cross section of a part of a convoluted tubule and of a part of such a tubule opened up, the cells being large and of the actively secreting kind.

The **Blood-vessel Arrangements** of the Kidney.—It has been mentioned in passing that the expanded ends of the tubules contain bundles of fine blood-vessels. Each kidney receives an artery from the main arterial trunk—the aorta—as it passes through the belly. The artery after entering the kidney splits up into various branches, which penetrate into the substance of the kidney. They reach the junction between the cortex and medullary regions, from which twigs pass up between groups of the convoluted tubules towards the surface of the kidney. On their way they give off branches. These branches penetrate the expanded ends of the tubules and immediately break up into a ball or tuft of capillaries, for which the expansion serves as a covering or capsule. The ball of capillaries is called a **glomerulus**; and it, together with its capsule, forms a **Malpighian body** of the kidney. The capillaries ultimately reunite to form a small vessel which passes out of the capsule, and speedily thereafter that outgoing vessel gives rise to a number of capillary blood-vessels which ramify over the convoluted tubules, affording, we may suppose, nourishment to their cells. These capillaries are then gathered together to form a small vein which joins other veins till large veins are formed, whose junction forms one large vein which goes off from the kidney, carrying away the blood

brought by the artery and pouring it into the vena cava (Fig. 137). Other arterial twigs proceed from the junction of medulla and cortex into the region of the pyramids of straight tubes, over which they ramify, to end in veins as the others. The chief point to notice is that the vessel that enters the capsule—the **afferent vessel** (Latin *ad*, to, and *fero*, I carry)—gives rise, directly or indirectly, to two sets of capillaries, those of the glomerulus and those that proceed from the vessel that issues from the capsule — the **efferent vessel** (*ex*, out of, and *fero*). *The outgoing vessel is smaller than the ingoing;* and the significance of this will appear immediately. Fig. 141 represents a Malpighian body with its entering and issuing vessels, surrounded by the capsule, the blind end of a tubule. Fig. 139 is a representation of the afferent vessel (1), arising from an arterial branch, forming the glomerulus, which ends in the efferent vessel (2), whose capillaries ramify over the convoluted tubes and end in a venous twig. In the Malpighian body the tuft of vessels is covered with a layer of small cells, so also is the inner surface of the capsule.

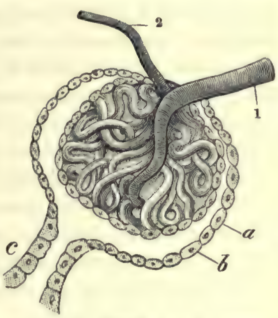

Fig. 141.—Malpighian Body of Kidney, with its tuft of vessels.
a and *b*, cells of capsule formed of widened end of tubule *c*. The wide vessel is the afferent; the narrow one is the efferent.

These details of structure show, to a great extent, how the kidney discharges its duties in separating waste matters from the blood, and what is the nature of the apparatus by which this is effected.

The Functions of the Kidney.—The business of the kidney is to separate certain substances from the blood which have gained access to it in its course through the body, and are the result of the decompositions effected in the tissues by their activity. The chief of these substances removed by the kidney is urea, a solid crystalline body. But the excretion of the kidney is a fluid — the **urine**—in which urea and various other organic and inorganic substances are in solution. What is known of the structure of the kidney indicates that in the formation of the urine there are two processes at work. One process is performed in the Malpighian bodies. An artery enters the capsule of the body and immediately breaks up into a tuft of capillaries. Now the blood is always exerting considerable pressure on the walls of the vessels, and the capillary vessels are very thin walled. One would at once conclude that fluid would ooze through the thin capillary walls and be received in the capsule. The capsule is the expanded end of a uriniferous tubule, so that the escaped liquid would find its way down the tubule, and so into the pelvis of the kidney, into which the tubule opens. As it collected in the pelvis it would flow into the ureter and so reach the bladder. In short, the structure of the Malpighian body suggests that it is a sort of filter, the filter being formed by the thin walls of the blood-vessels of the tuft with the fine layer of cells which covers them, having on one side of it blood under pressure and on the other side the cavity of the capsule (see Fig. 141). As the blood streams through the capillary tuft, fluid filters from it into the capsule, and the greater the pressure of the blood the more fluid will be passed through. Force and confirmation are given to this view by the fact that the vessel, which the capillaries of the Malpighian body form, and which leaves the capsule, is narrower than the entering artery. The supply pipe is larger than the escape pipe; blood passes into the Malpighian body more readily than it escapes from it. Consequently the blood in the capillaries will be at greater than usual pressure, and filtration of liquid from it will be encouraged. The structure of the apparatus, therefore, suggests that one part of the process of urine formation consists in the separation from the blood by filtration of certain of its fluid constituents. This does not, however, appear to be all. As soon as the blood has passed out of the Malpighian bodies in the efferent vessel it is distributed over the convoluted tubules by fine capillary blood-vessels into which the outgoing vessel breaks up (see Fig. 139). Now the convoluted tubules consist of a very delicate wall lined within by large active cells (Fig. 140), and blood is brought in thin-walled vessels into intimate connection with the tubes. These are just the conditions of secretion. The active cells of the tubules are separated from nourishing blood only by the thin walls of the tubes and vessels. It is therefore probable that the cells separate certain substances from the blood, which they work up and then pass into the tubule among the fluid filtered into the capsule and finding its way down towards the ureter. It has been, therefore, concluded that the process of

formation of urine consists of two parts—(1) of a separation of fluid parts of the blood *by filtration* in the Malpighian tufts, and (2) of a separation *by active cells* from the blood of probably more solid substances, which are added to the filtered fluid in its course down the tubules.

To this view of the action of the kidney there is one great objection. The blood is an albuminous fluid (pp. 216–217). Careful experiments have shown that if an albuminous fluid be placed on a filter the liquid that passes through contains albumen though in much less quantity than the original fluid, and that if the solution on the filter contains saline substances dissolved in it, these hinder the passage of the albumen, though they do not arrest it altogether. The experiments have also shown that as more pressure is exerted on the fluid on the filter more albumen will pass through with the fluid. If, therefore, the urine is largely a filtration from the blood under pressure, the fluid ought not only to contain some of the salts of the blood, but also some of the albumen, though less albumen ought to exist in the urine, because the blood is a saline solution, than would be if the blood were only albuminous and contained no salts. In health, however, the urine contains not a trace of albumen. Indeed, if a physician finds albumen in the urine of a patient he regards it as a grave sign of disease. It is then not easy to understand why, if the urine is mainly a filtration from the blood, it does not in health contain albumen. A view which explains this curious fact is that the fluid, as filtered through the vessels of the Malpighian tufts, is albuminous, but that, as the urine passes down the convoluted and other parts of the tubules, the active cells, lining their channels, seize on the albumen and pass it back into lymphatic channels, so that it may be again restored to the blood. When, therefore, the urine reaches the end of the tubule, and flows into the pelvis of the kidney, it has been entirely deprived of the albumen it possessed as it left the Malpighian capsule. It may be added that by this view one is able to explain various forms of severe disease of the kidney grouped under the term BRIGHT'S DISEASE, of which one of the most important symptoms is the occurrence of albumen in the urine. If the pressure of blood be very greatly increased in the capillaries of the Malpighian bodies so much albumen may thereby be passed through that the cells are not able to pick it all up, some escapes them and is detected in the urine. Again, the cells may be paralysed or otherwise rendered unfit for their duty by some condition of the blood, or they may have been destroyed by disease. In such a case though the albumen filtered from the blood is in ordinary quantity it is not picked up by cells of the tubules, and again its occurrence is detected in the urine. (Refer to the description of BRIGHT'S DISEASE in the second part of this section, p. 295.)

The Excretion of the Kidney—the **Urine.** The characters of the urine excreted by the healthy kidney are well defined; and they undergo marked alterations in disease. It will, therefore, be of value to state here the characters and chemical constitution of healthy urine and the chief alterations urine undergoes in disease. This will be of great value in understanding the results of the diseased conditions of the kidney described in the second part of this section.

Urine when freshly passed is of an amber **colour**, clear and transparent, and with a peculiar aromatic **odour** and of slightly acid **reaction**.

Its **specific gravity** is usually about 1020.

The **quantity** passed in 24 hours by a healthy adult man is between 50 and 60 fluid ounces. It varies not only according to the quantity of water taken in by the mouth, but according to the external temperature and the amount of exercise. The kidneys and skin co-operate to this extent, that if much water is removed by the skin as sweat, as in warm weather and after exercise, less is expelled by the kidneys. In cold weather the skin is less active, and a greater quantity of water will be produced by the kidneys. Nervous influences also affect the quantity. Thus after hysterical attacks a large quantity of clear urine is often passed.

Its **chemical constitution** is shown in the following table:—

	In 1000 parts.	Quantity in 24 hours varying between
Water	958	
Solids	42	
The solid constituents are—		
Urea	23·3	400 to 600 grains.
Uric acid	0·5	5 ,, 12 ,,
Chloride of Sodium (common salt)	11·0	150 ,, 200 ,,
Phosphoric acid	2·3	48 ,, 54 ,,
Phosphates of lime and magnesia	0·8	11 ,, 16 ,,
Sulphuric acid	1·3	23 ,, 38 ,,
Ammonia	0·4	9 ,,
Free acid	2·0	30 ,, 60 ,,
Various other substances—Kreatinin, hippuric acid, &c., in very small amount.		

The average quantity in 24 hours is of water 52 ounces, of solids 840 to 920 grains.

Gases, principally carbonic acid gas, nitrogen and oxygen being in very small quantity, are also contained in urine to the amount of nearly 16 per cent.

The solid constituents consist of two classes of substances: (1) inorganic salts, namely, common salt (chloride of sodium), sulphates, and phosphates, and (2) organic bodies, bodies containing nitrogen, namely, urea, uric acid, hippuric acid, kreatinin, &c. It is instructive to observe the sources of these substances. Chlorides occur in all the fluids of the body; sulphates arise from the decomposition of albuminous bodies; and phosphates have as their source albuminous bodies, the phosphates existing in bone, and phosphorus present in nervous structures. An excess or diminution in the quantity of any of these substances cast out of the body may thus aid in the recognition of a disease. Thus the quantity of phosphates in the urine is increased in diseases of nerve-centres and of bone.

The chief constituents, however, are the nitrogenous, urea and uric acid, the former specially, of which a large amount is excreted, as indicated in the table. Urea contains the four elements, nitrogen, hydrogen, oxygen, and carbon, nitrogen forming half its weight. While, therefore, the lungs expel from the body carbonic acid in particular, the kidneys expel nitrogen. Both of these substances show decompositions going on in the body, the carbonic acid being the result of the breaking down of starch, sugars, fats, and albumen also, while urea and uric acid are the products of the decompositions of nitrogenous bodies only, of which albumen is the type. The quantity of urea is always increased by a diet rich in albuminous food-stuffs. It is the last stage in the oxidation process which such food-stuffs undergo in their transit through the body. If it be not excreted by the kidneys a condition known as **uræmia** arises, described on p. 296. Uric acid probably represents a stage in the oxidation of nitrogenous bodies not so far advanced as urea. In human urine its quantity is very small (see table). In fevers and other unhealthy states of body its quantity is greatly increased, and since it is more easily dissolved in hot solutions than in cold, when the urine cools it becomes deposited in the form of a brick-red precipitate, making the urine muddy. When in excessive quantity, as in rheumatism and gout, it may form deposits in kidney or bladder, leading to the production of "stone," and in gout it is deposited in the fibrous structures around joints in the shape of chalk-stones.

Some colouring matter is also present in urine.

Unusual constituents of urine are albumen, sugar, bile, and blood. When albumen is present in urine it, as a rule, indicates some disease of the kidney, to which the term **albuminuria** has been applied. The presence of sugar indicates the disease **diabetes.** Both diseases are commented on in the second division of this section (pp. 295, 302, 303). Bile is another unusual constituent of urine, appearing in jaundice (p. 198). The appearance of blood is spoken of on pp. 302, 304.

THE URETER AND BLADDER.

The Ureter is the tube which leads from the kidney to the bladder, and is shown in Fig. 137 (p. 289). It enters the bladder at the lower part behind and to the side of the middle line. In length it is from 16 to 18 inches, and is about the size of a goose-quill. It is formed of an outer fibrous coat, a middle muscular coat, and an inner mucous lining with epithelial cells (p. 16) on its free surface. To its walls blood-vessels and nerves are distributed. Its channel is narrow, and it can be easily understood that if a stone has been formed in the kidney, and gets forced into the ureter, its passage down that channel will be accompanied by excruciating pain. The urine is conveyed from the kidney to the bladder by a wave of contraction passing along the ureters from the kidney to the bladder. It reaches the bladder not in a constant stream, nor yet in occasional gushes, but drop by drop, so that it gradually accumulates there.

The ureters open slantingly into the bladder, so that the urine finds its way into the bladder easily, but could not be readily forced up the tube from the bladder.

The Bladder is situated in the pelvis (p. 22, and Fig. 137, p. 289) in front of the termination of the large bowel. Its front face is in contact with the inner surface of the junction of the pubic bones (*sp*, Fig. 21, p. 22); and when full the top of the bladder projects above the bone. It is in this position that pain is felt when the bladder is strained by overfulness. When full the bladder is pear-shaped, when empty it is collapsed and lies low in the pelvis. It consists of three coats, an outer fibrous layer, a middle of muscle, of the unstriped variety, whose fibres run in bundles forming an irregular network, and an inner mucous layer with many layers of large epithelial cells on its surface. The peritoneum (p. 130) also in part covers the organ. From the small end of the bladder a canal passes—the **urethra,**

into which the bladder opens, and by which it is put in communication with the outside. The narrow end is called the neck of the bladder, and is surrounded, at the junction with the urethra, by a special bundle of muscular fibres, called the **sphincter of the bladder.** Urine cannot escape from the bladder unless the guard of the sphincter is relaxed.

The functions of the bladder are to collect and retain the urine from the kidneys until a certain quantity accumulates, and then to expel it in a stream. The urine enters its receptacle from the ureters drop by drop, and when the bladder becomes distended its emptying is effected apparently by a reflex nervous act (p. 86). An impression passes to a centre low down in the spinal cord. An impulse is thus originated by which the sphincter muscle is relaxed and the muscular walls of the bladder caused to contract. The channel being open, the contraction of the walls exerts pressure on the contained fluid which is thus expelled. Nervous diseases may affect the act of expulsion. The tone of the sphincter may be lost, so that the urine cannot be retained, or the bladder may be paralysed so that the fluid cannot be driven out. Irritations may exist about the neck of the bladder, or about the private parts, or due to worms in the bowel, which set up the reflex act and lead to a too frequent desire to empty the bladder. This is a frequent cause of children wetting their beds at night, the irritation originating the whole process, while the children are unconscious of it. Again there may be some obstruction to the escape of the urine. Nevertheless, the process being involuntary, the contractions of the bladder are set up, all the more vigorously since they are opposed, and thus the severe pain arises that is common in this condition. To this extent the action is voluntary, in that the result of the process may, for a time, be prevented by the will, or may be aided by voluntary effort producing contraction of the walls of the belly, and thus exerting pressure on the bladder.

Section X.—THE KIDNEYS AND BLADDER.

B.—THEIR DISEASES.

Diseases of the Kidney:

Congestion;
Inflammation (*Nephritis*)—Bright's Disease—Uræmia;
Suppuration;
Inflammation of the Pelvis of the Kidney (*Pyelitis*);
Gravel and Stone—Renal Colic;
Dropsy;
Rare Diseases of the Kidney—Cancer—Tubercle—Tumour—Movable Kidney.

Unusual Conditions of the Urine:

The Examination of the Urine—the detection of albumen, sugar, bile, blood, &c.
Albumen in the Urine (*Albuminuria*);
Polyuria (*Diabetes Insipidus*);
Sugar in the Urine (*Diabetes Mellitus*);
Blood in the Urine (*Hœmaturia* and *Hœmatinuria*);
Chylous Urine;
Suppression of Urine;

Diseases of the Bladder:

Inflammation (*Cystitis*);
Irritability;
Paralysis;
Retention and Incontinence (dribbling) *of Urine* by the Bladder;
Stone in the Bladder;
Cancer and Tumours.

DISEASES OF THE KIDNEY.

Congestion, Inflammation, and Suppuration—Bright's Disease.

Congestion of the kidney implies overfulness of the blood-vessels of the organ. This, it is plain, may be either because a much larger quantity of blood than usual is streaming into the kidney by the arteries, in which case the congestion is said to be *active*, or because, the usual quantity passing in by the artery, it is hindered in its escape along the veins, in which

case it is called *passive.* Active congestion may be the preliminary to fully developed inflammation; it may be the result of exposure to cold; it often is due to the irritant action of a poison circulating in the blood, such as that of scarlet fever, measles, or typhus, or the effect of the action of some medicine, Spanish-fly, turpentine, or cubebs. Thus irritation of the kidneys often occurs through the application of a fly-blister. The passive form arises when there is obstruction to the circulation, leading to accumulation of blood in the veins. Heart and lung diseases are frequent causes. Pressure on veins by a tumour will readily produce it, and thus in pregnant women the enlarged womb sometimes obstructs the flow of blood in the veins.

The **symptoms** are mainly connected with the urine, which may be increased in quantity and pale, while the patient complains of tenderness or some degree of heavy pain in the loins. Such symptoms would indicate active congestion. Usually, however, the quantity of urine is diminished, is high-coloured, and contains albumen, and sometimes blood, and what are called tube casts. The method of detecting these is described on page 302.

The **treatment** consists of rest in bed, hot applications over the loins or a warm bath, and a brisk dose of purgative medicine. But since the commonest cause of congestion is an obstruction to the circulation, its seat would require to be made out, and the treatment directed to aid its removal. That would imply an examination of heart and lungs, &c., which only a physician could properly perform.

Inflammation of the kidney (*Nephritis,* Greek *nephros,* the kidney—*Bright's Disease—Albuminuria*). There are various kinds of inflammation of the kidney dependent on the fact that the whole structure of the kidney is not at first attacked, the disease beginning at first only in the tubules (page 289), or in the blood-vessels (page 290), or in the fine connective tissue which acts as a framework for tubules and vessels; though after it has begun in one of these, it tends to pass to the others. Of late years different names have been given in order to signify in what portion of the kidney structure the inflammation has begun. All the various kinds are included under the general terms **Bright's Disease,** because it was Dr. Richard Bright, of London, who first, in 1837, showed the relation between certain symptoms, namely, the presence of albumen in the urine and dropsy, and alterations in the structure of the kidney. One symptom is common to all the forms of the disease, that is, the presence in the urine, in greater or less quantity, of albumen, which, as has been noted on p. 293, is never present in healthy urine. Hence another general term is sometimes employed to include the various forms of the disease, a term which simply points to the main symptom—albumen in the urine—the term **albuminuria.**

For the purposes of this work the simplest way of describing the various forms of inflammatory disease of the kidney will be to divide them into acute and chronic forms.

In **Acute Bright's Disease** it is the uriniferous tubules (p. 289) that are specially attacked. They become altered, and the cells which line them are swollen and cloudy. The flow of blood to the organ is excessive, so that it is congested. Fluid escapes from the vessels into the tubules, clotting there and so blocking the tubes, or blood may pass by rupture of the overloaded vessels. The cells tend to become fatty and to break down. The clotted material may be swept out of the tubes by the urine in the shape of casts of the tubes, as well as the diseased cells shed from the tubes and blood, so that these all appear in the urine when passed, and may be detected by appropriate means (see p. 302). The inflammation may so affect the kidneys that they are unable to discharge their function, urine ceases to be secreted, and the accumulation of waste matters in the blood causes death. The inflammation may cease before serious changes have occurred, and recovery then take place. It may gradually pass off, leaving blocked tubules, tubules stripped of their cells, blood-vessels thickened, &c., from which ultimate recovery may result so far as the patient's health is concerned, though the structure of the kidney has been permanently affected; or the disease may become chronic.

The commonest **cause** is exposure to cold and damp. It occurs frequently in the progress of scarlet fever, also during diphtheria, measles, typhus, and erysipelas, and other diseases. *It may follow excessive drinking.* Intemperate habits greatly favour its occurrence.

The **symptoms** of this acute attack are as a rule comparatively sudden in their onset. Chilliness followed by shivering fits and fever, accompanied by headache, thirst, dryness of the skin, sickness and vomiting, are the indications of some serious disorder. The seat of the disease is specially marked out by aching across the

loins, it may be mere uneasiness or dull pain. Dropsy, however, is one of the most important signs. It comes on often rapidly, and is specially observable in the face, which becomes puffy, and has a peculiar blanched look. It is earliest seen in the eyelids, and is also common about the ankles, and may be so great as totally to alter the appearance of the patient. The urine undergoes decided alterations. It is diminished in quantity, though it may be passed more frequently than usual, is high-coloured, and has a copious sediment. Examination (p. 301) reveals the presence of albumen in greater or less quantity, blood also and tube casts (p. 302). A sense of heat and pain generally accompanies its discharge. In very severe cases the secretion of urine almost or quite ceases. This is termed **suppression of urine**, that is, no urine is formed by the kidney, and is to be distinguished from **retention of urine**, in which urine is formed, but some obstacle to its discharge exists. Resulting from suppression is the condition termed **uræmia**, a condition due to the retention of waste matters in the blood which the kidneys ought to separate out, but are rendered unable to do. Its symptoms are headache, mistiness of vision, noises in the ears, oppression, dulness, drowsiness, sometimes delirium and convulsions, and it ends in complete unconsciousness (coma) and death. Now, setting aside the symptoms of suppression of urine, the others that have been noted would leave no doubt as to the nature of the disease, and prompt treatment would be necessary. But the symptoms are not so marked in every case. In some cases previous signs of an inflammatory disease are absent and there is no marked pain, the symptoms being limited to dropsy and alterations in the urine. Nevertheless dropsy and scanty albuminous urine are sufficient to warrant the conclusion of the presence of Bright's disease. The symptoms of recovery are lessening of the dropsy, increase in the quantity of the urine, which contains a diminishing quantity of albumen, the skin becoming more moist and of a healthier colour. Recovery may take place speedily within one or two weeks, or may be gradual, occupying several weeks or even months, or the case may pass into a chronic form.

Treatment. — The patient should be kept strictly to bed, clothed in flannel, and his room should be kept warm. Hot applications, poultices containing mustard, if the attack is acute, are useful over the loins; but fly-blisters or turpentine cloths should not be used. The action of the bowels and skin should be aroused. This is done by giving from 20 to 60 grains of the compound jalap powder, repeated every morning or every second morning, as seems desirable. The action of the skin is aided by doses of solution of acetate of ammonia (a dessert-spoonful) and spirit of nitrous ether (half a tea-spoonful) repeated every three or four hours. But, for this purpose, nothing is so useful and so safe as a hot pack. The patient is rolled, naked, in a blanket, wrung out of hot water, and is then surrounded by warm dry blankets. He should be kept in it for an hour or much longer if he feels comfortable. On the hot pack being removed the person should be quickly dried with warm cloths and enveloped in warm flannels. In the absence of medical advice this is the simplest and safest treatment to pursue whenever the symptoms seem urgent. The patient ought also to have plenty of water, lemonade, barley-water, milk, &c., to drink to help in washing away the material that tends to block up the tubules of the kidney. His diet should be mainly of milk and similar light material. On recovery great precautions must be exercised, as the least exposure might produce a relapse. Flannels should be worn, good nourishing food given freely, and quinine and iron administered to restore strength and tone.

Persons ought to be warned, however, that this is a most serious disease, even in its apparently mildest forms, and that, whenever possible, nothing should stand in the way of a sufferer from it being placed at once under responsible medical treatment.

Chronic Bright's Disease exists in a variety of forms (1) as a **chronic affection of the tubules**, the consequence of the acute attack just described, (2) in the form of **cirrhosis** or **thickening**, producing what has been called the **granular, contracted, or gouty kidney**, and (3) the **waxy or lardaceous kidney.**

The *first form* is frequently the result of taking cold. In it the tubules are permanently affected, their epithelial cells being removed, and the tubes blocked with broken-down material, wasting of the kidney following in time.

Its **symptoms** are chiefly alterations in the character of the urine and dropsy. The urine is scanty, contains albumen, and the use of the microscope discovers in it numerous cells from the tubules, and casts of the tubules. The patient has a doughy, puffy look, the dropsy filling up the furrows of the face, and giving a smooth, glossy appearance. Outbursts of the acute attack are liable to arise, and inflamma-

tory attacks of other organs and affections of the heart and arterial vessels are not infrequent.

The *second form* is most frequently caused by abuse of spirituous liquors, specially whisky or brandy. It is also associated with gout and with lead poisoning.

In this form the connective tissue between tubules and blood-vessels is the chief seat of the alterations of structure. It is increased in amount and by its pressure on the blood-vessels diminishes their supply of blood while it causes wasting of the tubules. The whole organ becomes greatly reduced in size by the shrinking of the connective tissue.

Symptoms of the disease may not be evident for a long time, unless they are symptoms of digestive trouble, common in all forms of Bright's disease. Sometimes the patient seeks medical advice owing to failure of sight, when a careful examination of the eye reveals changes in the retina, the nervous coat at the back of the eyeball, associated with a diseased kidney, whose existence was not before suspected. Dropsy may be absent or very slight. The urine is pale, increased sometimes in quantity, but does not always contain albumen, though usually in small amount. Associated with this form of Bright's disease in particular are alterations in the heart and arteries; affections of the lungs are common, bronchitis, pleurisy, &c., and uræmia, described in a previous paragraph, is the common cause of death. Recovery does not take place, but the person may live for many years, as the progress of the disease is very slow.

The *third form* of chronic Bright's disease, that of waxy kidney, is said to be the consequence of prolonged exhausting disease, such as prolonged suppuration, disease of bone, consumption, and syphilis. The kidney becomes altered in structure, the waxy change beginning, it is said, in the blood-vessels and spreading to the tubules, which become blocked up by a semi-transparent waxy material. As a result the kidney wastes and contracts.

Its **symptoms** are ill-defined, like those of the preceding form. The urine is very copious, pale, and watery, the patient having to rise several times in the night to void it. It contains little albumen at first, but the quantity increases. There is no dropsy. The patient gradually loses strength, but death may not result for several years, even five or ten, and is more commonly due to complications than to the disease itself.

Treatment of chronic Bright's disease. It is impossible to give detailed instructions as to the treatment of chronic forms of this disease. Its complications, affecting stomach and bowels, lungs, heart and blood-vessels, brain and other important organs are so numerous that the treatment appropriate for each case can only be decided by a physician who knows his work and who takes all the circumstances of the case into his consideration. Sometimes a careful scrutiny will reveal causes of the disease whose removal will tend to considerable improvement in the patient's condition, if not to recovery. Thus gout, syphilis, &c., should be treated if present. A general line of treatment can, however, be indicated, that is suited to all forms of the disease. The patient should avoid all exposure to cold and wet. He may be able to select a warm, equable climate, or a sheltered place of residence where he is not liable to sudden great changes of temperature. He should always wear flannels. He should take moderate exercise, and should attend to the condition of the skin, so that by strict cleanliness, and the frequent use of warm baths (taken, of course, with due precautions against cold), the free action of the skin is aided, and undue labour is thus prevented from being thrown on the kidneys. The bowels should never be allowed to become costive. In short, the patient must be surrounded by the healthiest possible conditions of life. The next object of treatment is the maintenance and, as far as possible, the increase of bodily strength. To this end the most nourishing food ought to be made use of, but of the most easily digestible kind. Milk in quantities may be allowed, and nourishing broths and soups, but the quantity of butcher-meat should be restricted. All albuminous food-stuffs (p. 132) throw work on the kidneys, since the result of their breaking down in the body is the production of urea, whose expulsion it is the business of the kidneys to provide for. Limitation of this kind of food, therefore, diminishes the quantity of urea and lessens the work of the kidneys. Chief among the means of strengthening the body is the administration of iron tonics, in the form of quinine and iron wine, or with strychnine as Easton's syrup (of which ½ to 1 tea-spoonful is a dose for an adult), and other similar preparations. *The use of ardent spirits should in all cases be avoided.* This is a general line of treatment, as already said. The treatment of dropsy, which is sometimes relieved by puncturing the dropsical parts, sometimes by free purgatives and by other means, as well as the treatment of other con-

ditions almost certain to arise in the progress of the disorder, is entirely dependent on the circumstances of the patient, of which, it must be repeated, only an educated medical man can form a proper estimate.

Suppuration of the Kidney is an inflammatory disease of the kidney accompanied by the formation of matter. The substance of the kidney is the seat of the disease, in which abscesses may form. It may be caused by inflammation passing upwards from the ureter or bladder, or by the irritation of stone in the kidney, or by a poisoned condition of the blood—pyæmia (p. 236), by injuries, or exposure to cold.

Among its **symptoms** are shivering fits (rigors), pain or uneasiness in the loins, albumen, blood, tube casts and matter in the urine.

Treatment consists in nourishing food and tonics.

Inflammation of the Pelvis of the kidney (p. 289), called by physicians **Pyelitis**, is another form of inflammation which can only be mentioned in such a work as this. It is caused by exposure to cold, stone in the kidney, by obstruction to the outflow of urine causing it to be retained and to become decomposed in the cavity, or by blood-poisoning, and it is marked by attacks of fever, pain in the loins, and changes in the character of the urine, which contains matter in chronic cases. If the obstruction persist owing to the retained materials, the kidney becomes converted into a tumour with fluid contents—decomposing urine and matter. It is difficult of treatment.

Gravel or Stone: Renal Colic: Dropsy of the Kidney.

Gravel or Stone (*Renal calculus*, Latin *ren*, a kidney, *calx*, chalk). The urine contains certain substances in solution, whose natural condition is that of a solid, and which, under certain circumstances, tend to separate out and, assuming the solid form, appear as a sediment in the urine. The chief of these are uric acid, combinations it forms with soda, ammonia, &c., called urates, and phosphates of lime and magnesia. (See p. 302.) Now uric acid may be present in the urine in excess, and as it is not a very soluble body it is readily crystallized out in the form of red particles. Anyone may cause them to be formed in healthy urine by adding a small quantity of strong hydrochloric acid to the urine and setting it aside in a tall glass for a day or two. In time small red particles will be seen forming on the sides of the glass—these, examined by a lens, are found to be crystals of uric acid. Various bodily conditions, connected specially with the digestive system, produce a deposit of uric acid, conditions due to too free living, excess in sugary and nitrogenous foods, and in heavy wines, beer, &c., indolent habits, and affections of the liver that accompany or are aggravated by such habits. Phosphates are held in solution in urine by its acid character, and if the urine becomes alkaline, the phosphates are precipitated. The urine is alkaline in various disorders of nutrition, in nervous dyspepsia, and conditions of general debility; and thus a deposit of phosphates occurs. But after quite healthy urine has been excreted by the kidney, it may undergo decomposition before it is expelled from the body; the result of decomposition is that the urine becomes strongly alkaline, and so again phosphates will be deposited.

Besides these two substances, uric acid and phosphates, there is another, oxalate of lime, which readily separates out from the urine. It should not exist in healthy urine, but appears there as the result of some interference with the due performance of the nutritive processes in the body, it being only a stage in the breaking down of non-nitrogenous food-stuffs.

We see then, that these three substances, uric acid, phosphates, and oxalate of lime, are liable, under certain circumstances, to separate out from the urine as a deposit. They may exist in the urine, however, in a state of such fineness as only to give an unusual cloudiness to the urine, a microscope being required to reveal that the cloud is actually due to solid particles. They may form larger particles capable of being felt or seen, in which case the deposit is termed **gravel**, while again they may form masses of varying size, to which the name of **calculus** or **stone** is given.

Now the deposit may be formed in any part of the urinary organs, from the urinary tubules or pelvis of the kidney to the bladder. A particle deposited in a tubule may be swept on to the pelvis, may be detained there, and grow in size from successive deposits on its surface, may pass to the bladder down the ureter, and being detained there continue to grow. There may, therefore, be stone in the kidney or stone in the bladder, or both. A gritty particle of uric acid swept from a urine tubule may become a stone of size before it is finally got rid of. It may reach the bladder as a uric acid particle,

and there, owing to decomposition taking place in the urine, it may be coated with phosphates, so that it consists of uric acid in the centre and phosphates outside.

Gravel thus differs from stone only in size; and the size of stone may vary from that of a pin's head to that of a goose's egg. The uric acid stones are the most common. They are smooth, hard, and reddish or yellowish brown in colour. Oxalate of lime stones are next in frequency, and form what is called the **mulberry calculus,** because of their appearance, being of a dirty purplish colour, and with a very irregular and rugged surface. Phosphatic stones are also common. They are smooth, light, and earthy in appearance. There are also stones formed of mixtures of these, as already mentioned, and also of other substances which are too rare to be noted here.

One stone may exist or several. They may be present in only one or in both kidneys. No age is exempt from them. They may be present in the kidney of the unborn child.

Symptoms. Gravel may be formed in the kidney and passed in the urine without any symptoms being present. Stone may be formed also without any manifestation, and its presence may be revealed only when it happens to be disturbed and makes an attempt to escape in the water. On the other hand the production and passing of gravel may irritate the kidney and occasion pain in the loins, and frequent desire to make water. The pain often extends downwards towards the groin and bladder, in the direction of the ureter, and is increased by exercise, especially by jolting movements such as riding in a carriage produces. Frequently also there is soreness during the passing of water, particularly at the end of the urethra. The urine is occasionally bloody, the blood not being in streaks, but intimately mixed with the urine. When a stone of any size attempts to pass down the ureter, the pain becomes acute, and is apt to occur in paroxysms, occasioning what is called **renal colic.** It begins suddenly, perhaps rises to intense agony, passes down towards the groin and testicle, which is drawn up (retracted), is accompanied by sickness and vomiting, the patient being bathed in warm perspiration, and frequently produces fainting and collapse. The attack lasts a varying time, sometimes a few hours, sometimes, with periods of relief, for days, and usually ends suddenly, either because the stone has reached the end of the ureter and has dropped into the bladder, or because it has been arrested in its course. The passage of one stone does not imply permanent relief, since others may form, and lead to other attacks.

Treatment depends on the condition giving rise to the production of stone. Uric acid stone is most common, and depends on a highly acid condition of the urine, so that steps taken to diminish its acidity will be useful. Moderation in food and drink must be carefully observed, animal food in excess, highly spiced dishes, and heavy wines being specially avoided. Water, barley-water, milk and water should be used freely to dilute the urine, and alkaline mineral waters, particularly Carlsbad, Friedrichshall, and Hunyadi Janos, to reduce the acidity of the urine. Change of air is also of great value. The administration of acetate or citrate of potash, 40 to 50 grains in a wine-glassful and a half of water, three or four times daily, is also highly recommended, to be continued for some months, but suspended for a time if the urine becomes ammoniacal. If oxalate of lime stone is suspected, keeping the urine dilute, by the means mentioned above, avoiding vegetables rich in oxalates, such as rhubarb and sorrel, promoting the action of the skin by exercise and bathing, and the use of the mineral waters already indicated, form the treatment. Since the deposition of phosphates depends on alkaline urine, the result of impaired health, tonic treatment is valuable, and the use of dilute nitro-muriatic acid (10 to 15 drops in water after meals) is urged.

The intense pain caused by the passage of a stone is relieved by hot baths, and hot applications to the loins and side. Opium or morphia in repeated doses is often necessary, but their administration is only safe in the hands of a medical man. Inhalation of chloroform may be necessary in the agony of an attack.

Dropsy of the Kidney (*Hydronephrosis*, Greek *hudōr*, water, and *nephros*, the kidney). This is a chronic disease due to an obstruction to the escape of urine from the kidney. The obstruction is in the ureter and may be in any part of its course, frequently towards the end near the bladder, and often due to a stone arrested in its progress towards the bladder. The result is that the pent-up urine widens the ureter and pelvis of the kidney, leads to wasting of the substance of the kidney by its pressure, so that in the end the kidney may be converted into a sac filled with fluid.

The detection and treatment of the condition it is needless to note here.

Rare Diseases of the Kidney.

Cancer, tubercle, and syphilitic disease may attack the kidney. Hydatid disease, similar to that occurring in the liver (p. 172), also occurs in the kidney.

Movable Kidney is the term applied when the organ is loosely connected to the wall of the belly, to which it is usually firmly bound, so that its position may be altered in various directions. It is more common in women than in men. It may give rise to no symptoms, or may occasion uneasiness and pain of a sickening kind.

Bandages are used to keep the kidney in position, and in particular cases an operation may be undertaken to fix it to the wall of the belly.

UNUSUAL CONDITIONS OF THE URINE AND THEIR DETECTION.

The Examination of the Urine.—A careful examination of the urine is capable of yielding very important indications of the state of health of a person. Sometimes the presence of a disease, quite unsuspected, is revealed by it, and it is a very common thing for physicians, unable because of vague symptoms to decide what is wrong with a person, to have all doubts set at rest by examining the urine. Moreover, such an examination frequently affords the most reliable evidence as to the progress a sufferer is making, whether towards recovery or towards a more serious state of disease. It will, therefore, not be out of place in a work specially intended for the guidance of persons not acquainted with medical science, to give a brief account of the main steps in such an examination. Besides such an account will help to show that the modern practice of medicine rests on a really scientific basis, and is not a mere rule of thumb, hap-hazard procedure. If this were fully realized by the public, the writer is confident it would lead to them taking greater care to place themselves, when the state of their health demanded it, in the hands of educated medical men, and would impress them with the risks they run in seeking the counsels of quacks and impostors.

The **appearance** of the urine should first be regarded. It ought to be quite clear and transparent, depositing after some time a light cloudy precipitate consisting of mucus from the urinary passages. The urine may grow muddy and cloudy when it has become cool, or soon after being passed. A small quantity should be placed in a test-tube or metal-spoon, and *gently* heated over a gas or spirit-lamp flame; if it clears up, the deposit is **urates**. This is due frequently to feverish states, and to disturbance of the digestive system. If the gentle heat makes it more cloudy, a few drops of common vinegar should be added. If it then clears up the deposit has been **phosphates**, and indicates that the urine has been alkaline. It should be noticed that if the urine has stood for some time this may have been due to decomposition in the urine. For urine when passed should be acid, but after standing for some days it undergoes decomposition and becomes alkaline, when phosphates are precipitated, making it muddy. It is only when phosphates appear in freshly passed urine, or in urine quite recently passed, that they are significant. Then they indicate decomposition occurring in the bladder, or an altered condition of blood and nutrition, requiring further investigation.

The nature of deposits other than those mentioned is determined by means of the microscope.

The **colour** of urine varies with the degree of its concentration. That which deposits urates is high-coloured. Other very high-coloured urines should be tested for blood and bile as mentioned further on.

The **quantity** of urine passed in 24 hours is between 2½ and 3 pints. It varies with the quantity of water taken, and with the activity of the skin, being less when the skin is active, as in warm weather, when it is of a darker colour, and greater when the skin is less active, as in cold weather, when it is pale and limpid. Nervous persons pass a large quantity of clear urine of low specific gravity (see POLYURIA, p. 302). When a constantly large quantity of urine is passed, it ought to be examined for sugar (see DIABETES, p. 303). Persons ought to distinguish between passing a large quantity of urine and passing it often. Irritability of the bladder will cause frequent desire to pass water, and the person may conclude that an unusually large quantity is voided. This is settled by collecting all that is expelled in 24 hours and measuring it. A constantly small quantity ought to lead to investigation for kidney disease.

The **determination of the specific gravity** of the urine is the next step in a systematic examination of the fluid. This is done usually by means of an instrument, called a **urinometer**, shown in Fig. 142. It consists of a glass bulb of an oval shape, loaded at one end by a small quantity of mercury, and prolonged, at

the other end, into a stem which has a series of marks on it at regular intervals, each mark having a number attached. The instrument is so constructed that if it be immersed in a tall glass containing distilled water, it will sink in the water for a certain distance and then float with the stem upright. The water will reach to the top score on the stem, marked 0. Now if 10 ounces of common salt be dissolved in 1000 ounces by weight of distilled water, and if the tall glass be nearly filled with this solution, and the urinometer placed in it, it will sink till the stem is immersed up to the mark 10, indicating that there are 10 parts of solid matter in every 1000 parts of the fluid. Suppose now the tall glass be nearly filled with urine, and the urinometer be placed in it, the level to which the stem is immersed in the urine can be read off, and thus the quantity of solid matters ascertained. If the urinometer floats at the mark 20, that means that in every 1000 parts of such urine there are 20 parts of solid matters dissolved, and so on. The specific gravity of urine is usually about 1020. But it varies with circumstances. Thus if the skin be very active or the weather hot a large quantity of water will escape by the perspiration, the quantity of water expelled by the kidney will be less, and the urine will contain a greater quantity of solids in proportion to its liquid parts. Again, if a large quantity of water or other dilute fluids be drunk, more water will escape from the kidneys and the urine will be more dilute. In order not to be misled by temporary variations one ought to collect all the urine passed in 24 hours, mix it, and take a sample of the mixture.

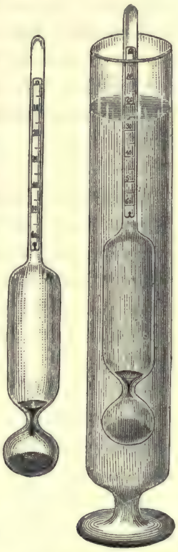

Fig. 142.—Urinometer.

A low specific gravity, 1015 or thereby, should lead to testing for albumen, not because the presence of albumen lowers the specific gravity, but because in albuminuria there is frequently a diminished quantity of the usual solids of the urine. A high specific gravity, 1030, 1035, &c., almost surely indicates diabetes.

The **acidity** or **alkalinity** of the urine is determined by the use of blue litmus paper, which remains blue if dipped into an alkaline fluid, but is changed to red if the fluid be acid. As already stated healthy urine is feebly acid when passed. After a little it becomes more acid, and then with decomposition it becomes alkaline. Urine may be affected in this direction by food and drugs, a diet rich in animal food rendering it highly acid, and one rich in vegetable diet or alkaline drugs (soda, potash, &c.) tending to make it alkaline. If there is no reason in the food for one condition or the other, further examination is necessary, lest the high degree of acidity indicate excess of uric acid in the system, as in gout or in the condition tending to the formation of uric acid stone, or lest, on the other hand, some affection of the bladder be causing premature decomposition of the urine and its consequent alkalinity, or lest some other serious condition of body be present.

The **detection of albumen** in the urine is of great importance. A small quantity of urine is heated to boiling in a test-tube over a gas or spirit-lamp flame, a few drops of acetic acid being added. If albumen be present in any quantity a white flaky precipitate appears, the thickened albumen. Any one can imitate this test by mixing a small quantity of white of egg with water, placing it in a test-tube and boiling. In extreme cases the urine may become almost solid. A simple way of performing the test is to take some urine in a metal spoon, add a few drops of vinegar and heat to boiling. If albumen be present in very small quantity this test is not delicate enough. A more satisfactory one is afforded by pouring the urine into a test-tube to the depth of from 1 to 2 inches, inclining the test-tube to one side and pouring down the side gently, and drop by drop, strong nitric acid, to the extent of half the quantity of urine. Then gently raise the test-tube to the upright position, taking care not to shake the fluid. The nitric acid and urine will be found to form two layers distinct from one another, the heavy nitric acid at the bottom of the tube and the urine above it. If albumen be present a white cloud appears at *the junction of the two fluids.* The success of the test largely depends on the two fluids being kept from mixing.

To detect bile take a small quantity of urine in a test-tube, drop in a small morsel of lump-sugar, incline the test-tube and slowly pour down the side a quantity of strong sulphuric acid (oil of vitriol) equal to that of urine. The acid forms a colourless layer at the bottom, urine is above it, and the piece of sugar is between the two. Raise the test-tube and watch

the junction between the two layers, the fluids being kept from mixing by shaking being prevented. The appearance of a deep purple colour indicates the presence of bile. A dark brown colour of burnt sugar, caused by the action of the acid on the sugar, must not be mistaken for the purple. Bile is present in the urine in jaundice and diseases of the liver, to which refer (pages 195 to 199). Another method consists in pouring some urine on a white porcelain plate and pouring beside it some drops of *fuming* nitric acid (nitric acid containing nitrous acid). At the junction of the fluids there appears a play of colours, beginning with green and going on to blue, violet, red, and ending in yellow. Both these tests give satisfactory results only in experienced hands.

To **detect sugar** in urine there are various tests. Fill a test-tube to one-third with urine, add an equal quantity of liquor potassæ, and boil the top of the mixture, by causing the flame of a spirit-lamp to play on the side of the tube. The appearance of a sherry-brown colour, deepening on continued boiling, indicates the presence of sugar. Another test consists in adding a drop or two of solution of sulphate of copper to urine in a test-tube, then enough liquor potassæ to give a clear dark blue solution, then boiling the surface of the mixture. If sugar be present a red or orange coloured precipitate appears. The presence of sugar indicates diabetes.

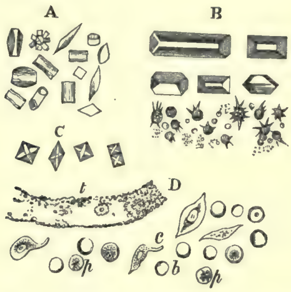

Fig. 143.—The Microscopical Appearance of certain Deposits of Unhealthy Urine.

A, Various crystals of uric acid, found in acid urine. B, The larger crystals are phosphates. These are found in alkaline urine. The small spiked balls, &c., are urates of ammonia. C, Crystals of oxalate of lime (see p 299). D, Organized deposits; *t*, tube cast; *b*, blood cells; *c*, cells of the kidney or bladder, *p*, pus cells (matter).

By examination with the microscope the presence of blood (see **Hæmaturia**, p. 304), matter, crystals of uric acid or oxalate of lime (see p. 299), cells from the kidneys or urinary passages, casts of the tubules of the kidney, produced by material capable of clotting, being poured into the tubes as a result of inflammation (see Bright's Disease), and other unusual constituents may be detected. The urine is allowed to stand for some time in a conical glass. A glass tube drawn to a fine point is passed down to the bottom and a few drops of the fluid are withdrawn. A drop is placed on the centre of a glass slide, used for microscopical purposes, and covered with a cover-glass. The slide is placed on the stage of a microscope and examined with a lens magnifying by 300 diameters. The forms of these various bodies are exhibited in Fig. 143.

Albuminuria is the condition in which albumen is found to exist in the urine. It is a symptom of disorder of the kidneys. (See Congestion of the Kidneys and Bright's Disease, pp. 294, 295.) The tests for albumen in the urine have been mentioned on the preceding page.

Polyuria (*Diabetes Insipidus*) is a disease characterized by the passage of large quantities of urine, of low specific gravity (1001 to 1010), and without the presence of albumen or other unhealthy constituent.

It is a curious and rare disorder, its cause being not understood. It is hereditary and has been known to be transmitted through four generations, and is related to true diabetes, in which sugar is present in the urine. It may occur at any age and to either sex. It may exist in the newly-born child, and is rather more common in early than in later life. It is supposed to be connected with tuberculosis (Sect. XIV.), disease of the brain, and intemperance. Its supposed connection with nervous disease is strengthened by the fact that the famous French physiologist, Claude Bernard, who found that a puncture in the floor of the fourth ventricle of the brain (p. 91) at a particular spot occasioned true diabetes, found also that a puncture in a slightly different situation produced polyuria.

Its chief **symptom** is the excretion of large quantities of urine, even larger quantities than in true diabetes. The urine is of low specific gravity and contains no albumen or sugar. Pailfuls of urine may be passed daily, and the person is tormented by constant desire to drink and to pass water. Thirst is present, and occasionally the appetite is great. A patient of the French physician, Trousseau, was paid by some restaurant keepers not to dine there, since the quantity of bread (supplied without extra charge) he consumed was enormous. Some suffering from this disease can drink large quantities of

intoxicating liquors without being in any way affected thereby. In many cases no other symptoms accompany the disease, and the patient may live to a good age. In other cases impaired health follows, though death is usually owing to some other affection.

No **treatment** of special value is known. The diet should be regulated, and tonics (quinine, iron, and strychnine tonic—see PRESCRIPTIONS) administered. Water should not be withheld. Ergotine, in doses of 2 grains twice or thrice daily, and continued for some time with occasional intervals, might prove of benefit.

Diabetes Mellitus (from Greek *dia*, through, and *baino*, I flow, and *melitta*, a bee; *Glycosuria*—*sugar in the urine*) is a disease of which the chief symptom is the presence of sugar in the urine.

Its **cause** is not known. Claude Bernard found that it might be artificially produced in animals by puncturing the floor of the fourth ventricle of the brain. It is sometimes hereditary and may be present at any age and in both sexes, being most common in adults from 25 to 60 years of age.

The **symptoms** are the passing of a constantly excessive quantity of urine, which gradually becomes more and more abundant, thirst, excessive appetite, dry harsh skin, and gradual loss of flesh and strength. These symptoms usually increase slowly. The urine is pale in colour, with a peculiar sweetish heavy smell; from 8 to 20 or 30 pints may be passed daily; it is of high specific gravity (1030 to 1040); and the presence of sugar is sometimes indicated by the patient noticing that it is attractive to flies, bees, &c. It rapidly ferments if kept in a warm place. The presence of sugar is determined by the tests mentioned on p. 302. The large quantity passed causes frequent calls to pass water. The thirst cannot be satisfied, and is accompanied by a parched and clammy condition of mouth and throat. Appetite is often voracious, though in the later stages it may be lost. The tongue is red and irritable, the gums inflamed and the teeth liable to decay. Costiveness is common. The body is wasted, the strength reduced, and languor and weariness produce disinclination to exertion. The harshness of the skin is marked, there is tendency to boils, and wounds do not readily heal. Failure of sight from the formation of cataract is frequent. While these are the symptoms of a marked case, sugar may exist in the urine without any prominent symptom leading to its detection. Specially is this liable to be the case when the disease begins in persons advanced in life. In two cases, under treatment by the writer, an intolerable itching about the genital organs led to an examination of the urine and the detection of diabetes, of which no other marked symptom was present. Stout people advanced in life may thus be affected without losing their stoutness, in whom dyspepsia and general weakness are the chief complaints. In such patients recovery is much more probable than in the fully evident disease, and the complaint is in no way so distressing. The disease is essentially a chronic one, though death occurs, in some cases, with great rapidity. The younger the patient the more grave is the disorder. From six months to three or four years is the duration of the disease, and it terminates by exhaustion or by other induced diseases. Consumption is liable to attack and carry off a diabetic person. Death sometimes occurs by coma (unconsciousness), and then it may be sudden.

Treatment.—The chief treatment consists in regulation of the diet. All articles containing sugar or starch (which is converted into sugar in the body) should be rigidly excluded. To show what substances may be eaten, because of absence of sugar or starch, and what may be drunk, as well as what ought to be avoided, because of the sugar or starch they contain, the following tables from Pavy are given:—

THE DIABETIC PATIENT MAY EAT

Butcher's meat of all kinds, except liver.
Ham, bacon, or other smoked, salted, dried, or cured meats.
Poultry. Game.
Shell-fish and fish of all kinds, fresh, salted, or cured.
Animal soups not thickened, beef-tea, and broths.
The almond, bran, or gluten substitute for ordinary bread.
Eggs dressed in any way.
Cheese. Cream cheese.
Butter. Cream.
Greens. Spinach. Turnip tops. *Turnips.
*French beans. *Brussels sprouts.
*Cauliflower. *Broccoli. *Cabbage.
*Asparagus. *Sea-kale. *Vegetable marrow.
Mushrooms.
Water-cress. Mustard and cress. Cucumber. Lettuce.
Endive. Radishes. Celery.
Vinegar. Oil. Pickles.
Jelly, flavoured but not sweetened.
Savoury jelly.
Blanc-mange made with cream but not milk.
Custard made without sugar.
Nuts of any description except chestnuts. Olives.

* *Those marked with an asterisk may only be eaten in moderate quantity, and should be boiled in a large quantity of water.*

Must Avoid Eating

Sugar in any form.
Wheaten bread and ordinary biscuits of all kinds.
Rice. Arrowroot. Sago. Tapioca. Macaroni. Vermicelli.
Potatoes. Carrots. Parsneps. Beet-root.
Peas. Spanish onions.
Pastry and puddings of all kinds.
Fruits of all kinds, fresh and preserved.

The Diabetic Patient May Drink

Tea.* Coffee.* Cocoa from nibs.*
Dry sherry. Claret. Dry Sauterne. Burgundy. Chablis. Hock.
Brandy and spirits that have not been sweetened.
Soda-water.
Burton bitter ale, in moderate quantity.

Must Avoid Drinking

Milk, except sparingly.
Sweet ales, mild and old. Porter and stout. Cider.
Lemonade. Ginger-beer, &c.
All sweet wines. Sparkling wines. Port wine.
Liqueurs.

Thus the patient must deny himself sugar in every form, and he must leave ordinary bread, biscuits, potatoes, and sweet vegetables out of his diet. This may be done gradually by dropping potatoes and taking only a small half-slice of bread well toasted, or bran bread well toasted. Special bread is made for the diabetic called gluten bread, made of flour out of which all the starch has been washed. It is unhappily not very palatable, and patients soon tire of it. Almond cakes may be used. For drinking, soda-water, or soda-water and cream is refreshing.

The patient should take regular moderate exercise, flannels should be worn, and warm baths frequently taken.

Many medicines have been tried, but none are very successful. Opium and ergot are probably the best, and may be taken in pill, containing ½ grain powdered opium and 2 grains ergotine, one thrice daily. In many cases the use of opium ought to be pushed, but not without medical supervision.

It should not be forgotten that the regulation of the diet is the chief treatment, and that a return to ordinary diet, because of the irksomeness of a restricted one, is almost certain to restore the worst symptoms. Efforts should be made, by constantly varying the kinds of food used, of those recommended in the first list, to diminish as much as possible the feeling of loss, because of the want of customary things.

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* *With cream but without sugar.*

Blood in the Urine (*Hæmaturia and Hæmatinuria*). Blood may exist in the urine under a variety of circumstances. It may come from the kidney, from the ureter, from the bladder, or other parts of the urinary tract. If it come from the kidney it is more likely to be uniformly mixed with the urine, which has in consequence a smoky colour, than when it comes from the bladder, when it is more likely to present the appearances of ordinary blood and to be less mixed with the urine. It may be passed in clots. Congestion of the kidney, or inflammation of various kinds, or the presence of stone may be among its causes, while growths or stone in the bladder commonly produce it. When it is in small quantity the smoky colour of the urine suggests its presence, and this may be most easily verified by discovering blood corpuscles in a drop of the urine examined by a microscope.

Paroxysmal hæmatinuria is the term applied to a curious affection, due to exposure to cold, in which the patient, after complaining of uneasiness across the loins and chilliness, becomes extremely cold, is pale, has an attack of shivering, shortly afterwards passes urine resembling porter, very dark coloured and muddy, because of the presence of blood. Sometimes sickness and aching in the limbs attend the attack, which soon passes off, but is liable to occur again suddenly after varying intervals. Sometimes the attacks occur after regular intervals. The poison of ague has been said to have a part in the tendency to the disease.

Treatment for bloody urine depends on its cause. When it is coming in any quantity the person should be kept quiet in bed. Cold compresses may be applied over the loins if it is supposed to come from the kidneys, or over the lower part of the belly if it is supposed to come from the bladder. If the discharge is profuse, 5-grain doses of gallic or tannic acid may be administered by the mouth every four or six hours while necessary. During the paroxysmal attacks the patient should be kept warm in bed. The prevention of the attacks is more easily accomplished than the treatment. Exposure to cold and wet should be avoided; the person should be clothed in flannel; and quinine and iron tonics should be taken.

In both kinds of cases, however, the determination of the causes of the disturbance is so difficult, and their recognition of so much importance, that no delay should be made in consulting a physician.

Chylous Urine (*Chyluria*) is a condition in which the urine is milky from the presence of chyle or lymph (p. 200) and clots, like size, on standing. It is a disease of tropical climates. In many cases the disease has been associated with a worm, the *Filaria sanguinis hominis*, occurring in the blood.

Suppression of Urine is the term applied when no urine is passed from the kidneys. It is to be distinguished from retention of urine (p. 306), in which the kidneys form urine which accumulates in the bladder. It is a very serious condition, occurring in the course of cholera, certain infectious diseases, and inflammations of the kidneys, and if continued leads to uræmic poisoning (p. 296). In cases of hysteria suppression of urine may last for some time without any symptoms of uræmia.

DISEASES OF THE BLADDER.

Inflammation of the Bladder (*Cystitis*) is of the nature of catarrh (p. 154), in which the lining membrane of the bladder becomes congested and swollen and pours out mucus. Breaches in the mucous membrane may occur leading to ulceration, blood may escape from congested vessels, and abscesses in the walls may be produced. Irritation of the bladder from the presence of stone, or from the retention of urine, occasions it. The irritation is sometimes due to substances in the blood. Thus poisoning by cantharides, the material of which fly blisters are made, occasions a very painful inflammation; and this may result from absorption from a fly blister placed on some part of the body. Extension of inflammation, such as that of gonorrhœa, excessive drinking, and exposure to cold, are other causes. The disease may be acute or chronic.

The **symptoms** are frequent passing of water, or constant desire to pass it, not much being expelled at a time, the act being accompanied by tenderness or burning pain. There is also tenderness or pain over the region of the bladder in the lower part of the belly, or in the groins, and in the region of the fundament. Fever is present. The urine is cloudy with mucus, or contains it in quantity, and blood may be mingled with it. In chronic forms the symptoms are less marked, but the urine is more altered and may be offensive to the smell.

Treatment.—Hot fomentations should be applied to the lower part of the belly or between the legs. Warm baths are useful. The bowels should be freely opened by a dose of calomel followed by castor-oil, or by a warm injection. If the pain is severe, 10 to 15 drops of laudanum may be given, at intervals of 2 or 3 hours, to be stopped when the pain is relieved. Plenty of watery drinks should be allowed, barley water, linseed tea, &c. The patient should be kept at rest, and only mild diet without stimulants allowed. Should the inflammation be due to the presence of stone or other irritant its removal is, first of all, necessary. In chronic cases it is important that the bladder be thoroughly emptied, and for this purpose the use of the catheter (see MEDICAL AND SURGICAL APPLIANCES) is often necessary. Baths or hot fomentations are useful for relieving pain. The medicines mostly used are infusion of the leaves of buchu, of red bearberry (*uva ursi*), of pareira brava, or of the root of dog's-grass (*triticum repens*). These infusions are made as one makes tea, one or two ounces of the leaves or root being used to one pint of boiling water. The dose is one to four ounces of the liquid three times daily. The freshly-prepared infusion is best; but fluid extracts may be obtained from chemists, of which one tea-spoonful in water is a dose.

Irritability of the bladder is indicated by frequent desire to pass water, the frequency not being due to an excessive quantity of water requiring to be voided. It is often due to excessive acidity of the urine, to irritation in the bowels, such as piles may induce, or in neighbouring organs, in women to irritation of the womb, in children to the irritation of worms. The irritation may be in the prostate gland at the neck of the bladder. Mere nervousness may occasion it.

Treatment.—The cause of any irritation should be sought for and removed, if possible. Excessively acid urine may be corrected by alkaline remedies such as citrate of potash (20 grains in water), excessively alkaline urine by 10 drops dilute hydrochloric acid in water, the doses being repeated several times daily as required. Belladonna ($\frac{1}{4}$ grain of the extract in pill) is useful, specially in nervous cases. If the person is in weak health quinine and iron tonics are called for. Plain diet is necessary, and all excesses should be avoided. Regularity of the bowels is of great consequence.

Paralysis of the bladder may be the result of injury or disease of the spine, or of parts in the neighbourhood of the bladder. Over-dis-

tention of the bladder often leads to inability to empty it properly. As a result either the urine is retained in the bladder or it constantly dribbles away. In such cases the catheter must be passed (see MEDICAL AND SURGICAL APPLIANCES).

Retention and Incontinence of urine.—In *retention* the bladder is constantly full and the patient cannot empty it. It is, however, commonly accompanied by constant dribbling of urine, so that the person thinks his bladder cannot hold the urine. He imagines his bladder is empty, whereas it is simply the overflow, the quantity that cannot find accommodation in the already over-distended bladder, that escapes. True *incontinence* is present when the bladder can retain no urine, and such cases are rare, occurring only in paralysis. As a rule in so-called incontinence, affecting usually men advanced in years, the bladder is over-full, being unable to empty itself, and only the overflow dribbles away. In the lower part of the belly the distended bladder may be felt as a tumour, and uneasiness is experienced there.

The **treatment** consists in passing the catheter and withdrawing the urine; and this requires to be done regularly till the bladder recovers its tone. Retention sometimes occurs suddenly—for example, to men on a journey who cannot get an opportunity to empty the bladder, and who, when the opportunity occurs, find they cannot then make water in spite of effort. Sometimes in such cases a hot hip-bath relieves.

Incontinence of urine in children is spoken of in the section devoted to DISEASES OF CHILDREN.

Stone in the bladder.—The causes of the formation of stone have been considered at p. 298.

Its **symptoms** are irritability of the bladder, frequent desire to pass water, and symptoms of chronic inflammation. There is pain occasionally at the neck of the bladder or point of the penis, aggravated by jolting exercise. The stream of urine is sometimes suddenly arrested by the stone falling over the opening from the bladder, and on the person changing his position it flows again. Blood frequently occurs in the urine. Stone cannot, however, be absolutely said to be present till a surgeon has detected it with a sounding instrument.

Treatment consists in crushing the stone by means of an instrument passed up the passage into the bladder, and allowing the fragments to be washed away in the urine. Such an operation is called lithotrity. The stone may be removed entire by means of an opening made into the bladder, through which the stone is drawn by forceps. This operation is called "cutting for stone" or lithotomy. Relief from some of the symptoms may be had by such measures as are recommended for inflammation of the bladder (p. 305).

Tumours of various kinds, cancerous and others, may occur in the bladder, and lead to symptoms of chronic inflammation, sometimes to serious loss of blood.

SECTION XI.—THE SKIN, HAIR, AND NAILS.

A.—THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Skin:

Its structure—Dermis and Epidermis;
Sweat glands;
Hair and Nail;
Glands (Sebaceous) *of the hair;*
Functions of the Skin—protection—excretion—the nature of sweat—regulation of temperature—absorption.

The skin occupies an important position as an organ of the body. It is a blood-purifying organ in as true a sense as the lungs or kidneys are, while it also performs other very important duties. It is not, therefore, merely a protective organ as is too generally supposed. It does form an external covering for the deeper tissues over the whole body, and that its protection is very necessary and efficient everyone knows who has experienced the pain produced by the contact of almost anything with a part of the body from which the top skin has been removed; but in some respects this is the least valuable, though the most apparent, of the functions it discharges.

Its structure is remarkably complex. The

skin consists of a deep layer called the **dermis, corium, or true skin** (*cutis vera*), and of a superficial layer—the **epidermis** (Greek *epi*, upon, and *derma*, the skin), **cuticle, or scarf skin** (*a*, Fig. 144). The true skin consists of fibrous tissue, the bundles of which form a felted interlacement. It lies upon a bed of fatty tissue (*c′ d*, Fig. 144) which fills up the inequalities of the surface on which the skin rests. Groups of the fat cells of this tissue also abound in the deepest layers of the true skin. Pervading the fibrous tissue is also an abundance of fibres of the elastic sort (p. 16) which confer elasticity on the skin. The true skin (*b–e*) is very vascular, that is, is richly supplied with blood-vessels, so that when cut it bleeds; and nerve fibres are likewise disposed in it, conferring sensibility. The surface of the true skin is thrown into a series of elevations, papillæ, or finger-like prominences (*b*, Fig. 144) which are specially rich in capillary blood-vessels and nerve endings, and which are thus particularly vascular and sensitive. Above the true skin is the scarf skin, the projections of the former fitting into excavations in the latter. The epidermis, however, is composed entirely of cells, and is quite devoid of blood-vessels or nerves, so that it may be cut without bleeding or pain. There are several layers of cells, and the shape of the cells alters from the deep parts upwards. The cells directly lining the surface of the true skin and the papillæ are columnar and nucleated. They are soft and active cells, and clothing the papillæ are several layers of them. In the layers nearer the surface the cells lose their columnar shape and become more flattened. They also gradually become less soft and more horny, until towards the surface they are flattened and scale-like. The surface scales are continually being thrown or rubbed off, and their places are supplied by deeper cells which reach the surface by growth from below. New cells are continually being produced in the deep layer in contact with the true skin; and as they are formed they push upwards the already existing cells. So that cells originally active and columnar gradually pass upwards, becoming horny, till they are finally cast off. The fine white dust that one may scrape off the skin consists of these horny scales.

Fig. 144.—The Structure of the Skin.

It is in the deep and active layers, called the **rete mucosum**, of the epidermis that colouring matters are present, which give the hue to the skin. For example, in dark races black pigment is present in these cells. The epidermis is thickest over the parts exposed to greatest pressure or friction, securing protection to the sensitive true skin below.

At the openings of the body the skin passes into mucous membrane, the structure of the two being practically identical, the differences being merely in the thinness of the epidermal covering of the mucous membrane and the increased supply of blood to the membrane.

Glands of the Skin.—The special glands of the skin are the **sudoriparous** (*e*, Fig. 144) or **sweat glands** (Latin *sudor*, sweat, and *pario*, to bring forth). They are tubular glands. Deep in the substance of the true skin, or in the fatty tissue beneath it, the tube is coiled up into a sort of ball. From the coil the tube passes upwards through the true skin, following a wavy course, till it reaches the epidermis, which it penetrates in a spiral manner till it opens on the surface. Two of such glands are shown in Fig. 144 (*e e′*). The tubes consist of delicate membranous walls lined within by cells. The coiled part of the gland is surrounded by a dense network of fine blood-vessels, and thus the cells of the gland are separated from the blood by only a very fine membranous partition, and can draw from it what supplies they need for their particular work.

It is estimated that the total number of sweat glands in the human skin is over two millions. They are not, however, equally distributed over the body. They are fewest in the back and neck, where it is estimated there are on an average 400 to the square inch. They are in greatest number in the skin of the palm of the hand, where they amount to nearly 3000 in each square inch, according to Erasmus Wilson, 3528. Their openings occur on the ridges into which the skin is there thrown, and may be made out by a hand lens. Next to the palm of the hand they occur in greatest number in the sole of the foot, next on the back of the hand and foot, and the smallest number is that already noted in the skin of the back. The length of a tube, when fully straightened out, is about $\frac{1}{4}$ inch; so that, according to Sir E. Wilson, in

one square inch of skin from the palm of the hand there is a length of sweat tube equal to 73½ feet. Estimating the number of glands in the body to be between two and three millions, the total length of tube devoted to the secretion of sweat would be about *10 miles.* According to Erasmus Wilson's estimate it amounts to even *28 miles.*

Hair.—Hairs and nails are originally derived from the epidermis, and are essentially cellular structures. A hair is formed by a folding or dipping inwards of the skin. A depression or furrow is thus formed, the inner walls of the depression consisting of the infolded epidermis. The depression takes the shape of a sac and is called the **hair sac** or **hair follicle.** At the bottom of the follicle is an enlarged papilla of the true skin (*c*, Fig. 145) pushed downwards by the folding-in process. Like the

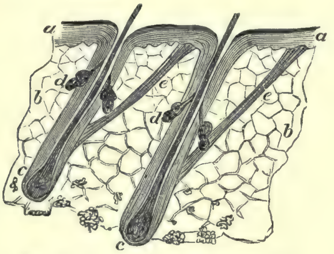


Fig. 145.—Hair, Hair Follicles and Glands.

a, epidermis; *b*, true skin; *c*, hair bulb; *d*, sebaceous glands; *e*, muscle and hair sac.

other papillæ of the skin it is covered with the active cells of the deep layer of the epidermis, which form a bulbous enlargement over the papilla, that is, the root of the hair. As the cells in direct contact with the papilla grow and multiply those above them are pushed upwards to make room for them, and owing to the shape of the hair sac the cells become packed together so as to form a cylinder or stem, which finally, as the growth from below goes on, is pushed out beyond the skin as the shaft of the hair. A hair thus consists of a peculiar arrangement of the cells covering the true skin. So closely are the cells packed to form the cylinder that a fibrous appearance is presented, except in the centre of the hair—the medulla—where the cells still retain their shape, and make the hair appear different in the centre from the circumference. The hair is thus *not a tube but a solid rod* composed of cells packed tightly at the circumference and loosely in the centre. Sometimes little spaces exist in the centre owing to absorption of cells, and the spaces are filled with air, giving in some parts the appearance of a tube, when the hair is examined under the microscope. The different colour of hair is due to pigment present in the cementing substance between the cells as well as in the cells themselves.

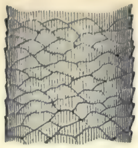


Fig. 146.

Fig. 146 shows the appearance under the microscope of a hair, the cells overlapping one another like tiles on a roof.

Glands of Hair.—Opening off from each hair sac are one or two glands (*f*, Fig. 144), the **sebaceous** glands (Latin *sebum*, tallow). They are also shown in Fig. 145, *d*, and consist of groups of minute sacs lined with cells, which produce an oily material to lubricate the hair and skin. Connected with each hair sac, especially if of a good size, is a bundle of involuntary muscular fibres (*e*, Fig. 145). The bundle passes in such a direction that, when it contracts, the hair sac, which is placed obliquely in the skin, is caused to become more upright, and thus the hair is made "to stand on end." It is this that causes the appearance of "goose's skin."

A **Nail** is also a compact mass of epidermal cells. At the bottom of a fold on the skin is the root of the nail, at which growth takes place by multiplication of cells. The nail is thus continually pushed forward by the growth behind. The bed on which the nail rests, and from which it also receives additions, is formed by numerous papillæ of the true skin.

Just as in man hair and nails are altered epidermal structures, so the feathers of birds, and the claws of animals, are formed from the surface layers of the skin.

Functions of the skin. Manifestly the skin *covers in and protects* the more delicate structures that lie beneath it. This it does by means of the horny and insensitive epidermis; for everyone knows that if an injury tears off the cuticle the uncovered true skin is keenly sensitive to the slightest contact with any foreign body, and to heat and cold. The epidermis also protects from the absorption of poisons, for one may handle with impunity, when the skin is whole, substances which, gaining access by the smallest wound, might cause serious injury. The skin, however, ranks as *an excretory organ* of importance. Its excretion is called sweat, and is the product of the sudoriparous glands. In addition the sebaceous glands secrete an oily fluid useful for lubrication.

The sweat or perspiration is a colourless transparent fluid, consisting chiefly of water, but containing a small quantity of saline material and traces of urea, and being of acid reaction. In some parts of the body, and especially in the arm-pits, the glands secrete a substance having a peculiar smell. It would seem also that some carbonic acid gas passes off by the skin, but not more than $\frac{1}{50}$th of what escapes by the lungs. In ordinary circumstances the sweat passes off from the skin as vapour as fast as it reaches the surface. One would readily conclude, therefore, that usually the skin is not active. This is not so. On an average the quantity of water that escapes from the skin as vapour is about 2 lbs. daily. If strong exercise be engaged in, or if the body be exposed to great external warmth, particularly when the external air is moist, the sweat becomes more abundant, and, unable to pass off quickly enough, collects on the surface in drops. A distinction is, therefore, drawn between **insensible perspiration**, the perspiration that passes from the skin unseen as vapour, and **sensible perspiration**, the sweat that collects on the surface. The distinction is worth noticing, since water is continually being lost from the surface of the body, though at times it is quite apparent, and at other times not so. A man's weight may be reduced several pounds in an hour by loss through perspiration alone. To some extent this may explain the weakening effect produced by excessive sweating in the course of some diseases, for example the night-sweats of consumption.

It is in the coiled part of the sudoriparous gland that the sweat is produced. The blood that surrounds the coil in capillary vessels is in intimate connection with the cells of the gland, and it is from the blood that the cells separate the materials that form the perspiration. It is thus apparent that the greater the quantity of blood flowing to the skin the more sweat is likely to be formed. The blood-vessels of the skin, like the blood-vessels of other parts of the body, are under the control of the nervous system, by which their width is regulated. If the nervous control is removed the blood-vessels widen, more blood flows through them, and more raw material is brought to the glands. In other ways the blood-vessels may become more fully charged with blood than usual. External warmth relaxes the skin and the vessels; there is thus a determination of blood to the skin and increased perspiration. On the other hand external cold causes the skin and vessels to contract, diminishes the supply of blood, and lessens the amount of sweat. By such a process as this the skin is able to discharge a third function, that of **regulating the temperature of the body**.

The transition of a liquid to the state of vapour is always accompanied by a loss of heat. Heat is necessary, that is to say, to convert a liquid into a vapour. Any liquid that very quickly evaporates produces, when placed on the skin, a marked sense of coldness, because the heat necessary to transform the liquid into vapour has been drawn from the skin, and withdrawn quickly. Even so, every particle of sweat that reaches the mouth of a sweat gland and passes off into the air carries with it a certain quantity of heat from the body, and cools the body by that amount. It is this that makes one so readily feel chilly after excessive sweating, the evaporation of a large quantity of sweat rapidly cooling the surface. Now, if the atmosphere be very warm, a greater quantity of sweat will be produced, as we have seen, and its evaporation will tend to prevent the heat of the body rising. Whereas, if the atmosphere is cold, much less sweat is produced, and the loss of heat from the body is greatly lessened, and its temperature prevented from falling. Thus the skin greatly aids in maintaining an average heat of the body, and in preventing rises and falls of its temperature with every variation of the external atmosphere.

It would seem also as if the nervous system had some direct action on the sweat glands. Fear or other strong emotion often causes sweat to break over the skin even while the surface is very pale and the quantity of blood diminished. Cold sweats are frequent in the extreme depression that precedes some forms of sickness or fainting. It is probable that such outbursts of sweat are due to some nervous influence accompanying the general condition and acting directly on the sweat glands.

Many drugs influence the process of sweating either by increasing the amount or by diminishing it. Thus opium causes profuse sweating, while atropine, the active principle of belladonna, is capable of completely arresting it.

The reason for giving medicines to excite sweating during the course of some fevers is plain. By promoting the activity of the skin they tend to reduce the heat, and, moreover, by increasing the quantity of material separated from the blood they widen a channel by which unhealthy stuff that may exist in the blood and be the cause of the disturbance may be swept out.

Some relationship exists between the skin

and kidneys. In cold weather, when the skin is less active, a large quantity of water is passed off by the kidneys, while in warm weather, or under circumstances producing great activity of the skin, the quantity of water separated by the kidneys is proportionately diminished. This is a point of great importance. It indicates that, when disease of the kidneys is present, these organs may be relieved to a considerable extent and their labour lessened by any means which excite perspiration.

If the skin be covered over by varnish, so that its functions are completely arrested, death speedily results. The reason is not known, though many explanations of the circumstance have been offered. After varnishing the bodily heat falls very rapidly, due, it has been said, to the blood-vessels of the skin becoming very wide, permitting a large flow of blood to the surface and rapid cooling in consequence. In animals that have been varnished death has been delayed for a considerable time by wrapping them in cotton wool, and thus hindering the great loss of heat, or by placing them in some warm place to maintain the temperature. This, however, does not seem to explain all the effects of varnishing the skin. Symptoms of blood poisoning arise, and albumen appears in the urine, in fact symptoms similar to those of uræmic poisoning, which is described on p. 296. The retention of poisonous matters in the blood, owing to the activity of the skin being set aside, would explain such symptoms. Some confirmation of this view is afforded by the statement of a German observer that the injection of filtered sweat caused fever and albumen in the urine.

Tarring and feathering, the punishment of mob-law in some parts of America, have effects similar to those of varnishing the skin, and cause a painful death after some time. The hot tar, poured over the body, so enters and closes up the pores of the skin, that it is practically an impossibility to remove it. The effort to wash off the tar by scrubbing, &c., is attended by extreme pain, because the fine hairs all over the body become so embedded in the tar that they are pulled out in the process. Probably the best method to remove it would be to seat the person in a bath of turpentine, if such could be obtained, and to rub only with the hands. If, in such a case, patches of the skin could be cleaned here and there, so that their activity could be restored, these patches would sufficiently discharge the functions of the skin to avert a fatal result. For this purpose turpentine or benzine would be the best agent to employ.

Finally, the skin seems capable of absorbing matters to which it is freely exposed, and of passing them onwards into the blood. Fluids in contact with the skin, and solid substances rubbed into it, may be absorbed. Thus cases are on record where persons have gained weight by exposure to a moist atmosphere, or by immersion in a bath. Sailors, deprived of fresh water, have been able to allay their thirst by wearing their clothes soaked in salt water. Mercury and other ointments rubbed into the skin are capable of acting on the system, apparently because particles gain entrance to the lymphatics. The extent to which absorption occurs through the sound skin, however, is not great. Even where vigorous rubbing is performed to force the particles into the mouths of the glands the absorption is limited. But from parts where the scarf-skin has been removed, various substances may be picked up and passed rapidly into the blood. Sometimes, therefore, where it is thought desirable to act through the skin, a small blister is applied, and the substance —morphia powder, for example—dusted over the raw surface.

The part played by the skin in touch will be considered in the section on the organs of sense (p. 335).

These considerations as to the functions of the skin ought to render it apparent that the skin is a very important organ of the body. It is not, however, generally viewed in this light. At least it very often does not receive the care and attention which, as such, it deserves. It will be apparent that the minute openings of the sweat glands—the pores of the skin as they are called —may be easily blocked by worn-out cells of the cuticle or by materials deposited by the drying of the sweat, and that, to keep the skin free and active, constant cleansing is necessary. If systematic cleansing of the surface of the body is not practised, not only will the skin fail to separate from the blood the waste products it ought to expel from the body, but more labour will be thrown on other organs, and specially, as noted above, on the kidneys, to counteract its inefficiency. Thus uncleanliness may not only cause disease in the skin, as will be seen in the next part of this section, but may help to excite disease in other parts.

SECTION XI.—THE SKIN, HAIR AND NAILS.

B.—THEIR DISEASES AND INJURIES.

Eruptions of the Skin:

The *pimple* (papule), *vesicle, pustule, bleb* (bulla), *tubercle, wheal, tumour,* and *stain* (macule);
The *excoriation, crust, crack,* and *scar* (cicatrix);
Desquamation.

Inflammatory Affections of the Skin:

Inflammatory Blush (*Erythema*)—Erythema nodosum;
Rose-rash (*Roseola—False Measles*);
Nettlerash (*Urticaria*);
Erysipelas (*The Rose—St. Anthony's Fire*);
Boil (*Furunculus*) and *Carbuncle* (*Anthrax*);
Ulcers;
Herpes—Herpes of the Lip;
Shingles (*Herpes Zoster*);
Pemphigus;
Eczema (*Moist Tetter*);
Psoriasis (*Dry Tetter*);
Dandruff (*Branny Tetter—Pityriasis*);
Impetigo (*Pustular Tetter—Honey Scab*);
Lichen—Strophulus—Red Gum Rash.

Overgrowths, New Growths, and Hæmorrhages of the Skin:

Barbadoes Leg (*Elephantiasis Arabum*);
Fish-skin Disease (*Ichthyosis*);
Leprosy (*Lepra—Elephantiasis Græcorum*);
Lupus;
Freckles; Corns; Warts; Horns; Moles (*Mother's Mark—Nævi*);
Purpura Hæmorrhagica;
Cancer and Epithelioma.

Itching Diseases and Diseases due to Insects:

Itching (*Pruritus*);
The Itch (*Scabies*);
Lousiness (*Phthiriasis—Pediculosis*);
Eruptions due to Fleas, Bugs, Gnats, Mosquitoes;
Ringworm (*Tinea Tonsurans*);
Favus (*Honeycomb Ringworm*);
Pityriasis Versicolor.

Affections of the Glands of the Skin:

Excessive secretion of sebaceous glands (*Seborrhœa*);
Comedones (*Shilfcorns, Grub*); *Milia; Wens; Molluscum;*
Excessive or altered secretion of sweat—Stinking Sweat;
Miliaria (*Sudamina*)—Prickly Heat;
Acne (*Face Pimples*)—Acne of the Beard; *Acne Rosacea.*

Injuries to the Skin:

Wounds; Burns; Chilblains and Frostbite.

Affections of the Hair and Nails:

Excess of Hair (*Hirsuties*); *Hairy Mole;*
Baldness (*Alopecia*) and *Greyness of Hair* (*Canities*);
Inflammation of Nails (*Onychia*);
Excessive Growth of Nail—Ingrowing Nail.

The Care of the Skin, Hair and Nails.

The diseases of the skin are numerous, and many of them are troublesome. Its structure, as indicated in the first part of this section, is comparatively complicated. The true skin itself is supplied with blood-vessels and nerves, and is therefore liable to various forms of inflammatory change to which any other structure rich in vessels and nerves is exposed. But there are also to be taken into account the sweat glands and canals that are imbedded in and pass through it, and the appendages that belong to it, in the shape of hairs and nails with their attendant glands, all of them liable in themselves to various departures from a healthy condition.

Moreover, the skin ranks as a blood-purifying organ in as true a sense as the lungs or the kidneys, though in a less degree, and it may thus be not only the seat of a disease which affects it exclusively, but may likewise be a sharer in an unhealthy condition that disturbs more or less generally the rest of the body. A disease of the skin may be, that is to say, a mere local disturbance, an affection limited to the part where it is manifested, or it may be the indication and result of a general condition of body. Thus the eruptions, or rashes, that attend many special fevers, such as scarlet fever, measles, typhus and typhoid fever, &c., are evidently mere occurrences in the course of a disease affecting the whole body. No one would think of treating these eruptions by themselves, for they will gradually disappear as soon as the constitutional disturbance, in whose train they come, has passed away. But there are other eruptions, as well as affections of the skin not attended by any rash, as truly produced by a general disorder, not to be got rid of till the general disorder has been set right, that are not so readily traced to their true cause. Here, however, an error must be guarded against. It is a common belief that many skin diseases are peculiarly the expression of a "vice of blood," which is seeking an outlet in this way, and that, if this way of escape is denied to it, it will, in revenge as it were, attack deeper and more vital parts. The common conclusion, accordingly, is that the disease ought to be permitted to run riot through the skin, if it pleases, lest attempts to cure it drive it inwards. Now we have seen (p. 308) that the skin is a blood-purifying organ, that by means of its glands it separates from the blood and casts out of the body certain impurities. It is also true that in fevers, accompanied by rash, such as measles, scarlet fever, &c., the treatment consists in the use of warm baths or hot packs, and in the administration of medicines which, besides relieving the bowels, "determine to the skin and kidneys," as the phrase is, that is stimulate the activity of skin and kidneys to be more vigorous in their work of purifying the blood, to aid in "throwing off" the disease, or at least in abating its severity. As a sign that this is being done, so far as the skin is concerned, one is accustomed to view with satisfaction a rapid and full development of the rash characteristic of the disease. While this is all true, it is a totally wrong view of the facts that encourages the idea that a cure of any skin eruption runs the risk of creating disease elsewhere. It never is so. Many skin diseases are entirely local, are due, that is to say, to disturbances limited to the part affected, the cure of which implies that the disturbances have been got rid of. In those cases where the skin eruption is only a symptom of a constitutional disease, the cure of the eruption is always to be regarded as a sign that the constitutional defect is being remedied. In all cases, consequently, skin diseases should be submitted to treatment; and that treatment is the best which most rapidly and thoroughly restores the skin to its healthy condition.

In this section the eruptions of the skin that attend the acute fevers are not considered, but are discussed in the section on acute fevers. Apart from these the various affections of the skin are reviewed in this section, and are classed under different headings. Various classifications have been proposed by different authorities, none of which is employed here, the arrangement used being dictated simply by convenience. Inflammatory affections of the skin are first discussed, then growths and tumours, itching and parasitic diseases, affections of the sweat glands, affections of the hair and sebaceous glands, and affections of the nails.

First, however, as a great many skin diseases are attended by visible alterations in the surface, discoloration, or elevations of the surface in the form of eruption, &c., and since the nature of such change is some guide to the character of the disease, it will be well to explain the terms employed to distinguish between various forms of such alteration.

Various forms of Eruption (Rash), &c., of the Skin.

The pimple or papule is a solid elevation above the level of the skin, between a millet seed and a lentil in size. It apparently contains no fluid. It may be of the colour of the natural skin, reddish, bluish, or black, &c. Pimples are commonly connected with the glands of the hair, due to effusion of material prevented from escaping, or they may be due to inflammatory swelling of the papillæ of the true skin. Their presence gives a feeling of roughness to the skin, and may occasion severe itching and tingling.

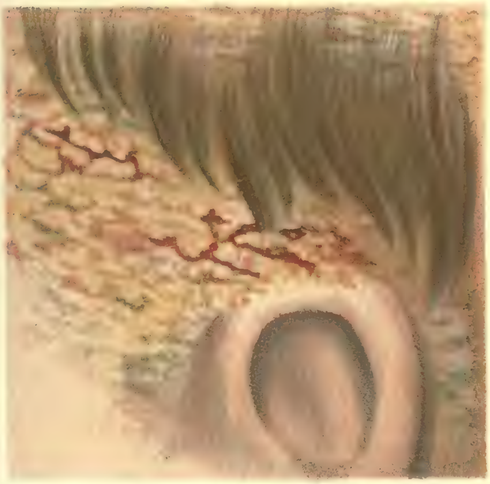
The vesicle is an elevation of the upper horny layer of the skin by fluid accumulated between it and the deeper layers. It is of the size of a pimple, and the fluid is clear or milky. The thin covering may burst and the fluid escape, or it may evaporate, or the clear fluid may become yellow and a pustule be formed.

Crusted or Honeycomb Ringworm - Favus p 3[illegible]

Bald Spots (Tinea decalvans) - Alopecia p [illegible]

Ringworm of Scalp - Tinea tonsurans p [illegible]

Spotted Rose Rash (Erythema nodosum. p 313



Running Scab or Moist Tetter - Eczema. p 318

Nettle Rash - Urticaria p 314

A pustule is the same as a vesicle, but instead of clear fluid it contains yellow matter—pus. A vesicle becomes a pustule if the clear contents of the vesicle alter their character as they often do.

A bleb or bulla is the same as a vesicle except in size. They may be as large as walnuts, or even hen's eggs, or still larger. The contents of the bleb may, however, be pus.

A tubercle is a solid swelling larger than that to which the term pimple is applied, but of a similar kind.

A wheal is the term applied to a raised portion of skin of greater extent than thickness. It may be of varying shades of red, and is generally flat. It is due to swelling in the upper layer of the true skin itself.

A tumour is a solid swelling, in size between a walnut and a man's fist, situated in the deeper layers of the skin.

Lastly, there is the **stain or macule, or spot** caused by a change in the ordinary colour of the skin. Spots may be of varying colour, white, red, blue, yellow, brown, &c., and of very different sizes. They are not raised above the surface. They may be produced by blood being poured out in the substance of the skin at mere points here and there or in patches. The blood spot passes through changes in colour, blue, green, and yellow, before it disappears.

These various forms of eruption are not necessarily separate and distinct kinds; for the pimple may become a vesicle, and the vesicle may change to a pustule, and the condition that produces the pimple will give rise to the tubercle if a larger extent of surface be affected. Similarly the difference between a vesicle and a bleb consists simply in the size of the area affected.

Moreover, scratching, rubbing, &c., effect alterations in the appearance of the eruption. In itchy diseases frequently the original form of the eruption is not recognizable because of the effects of scratching. The heads of pimples may be knocked off so that blood oozes in drops and hardens on the pimple, changing its appearance. The skin covering vesicles, pustules, &c., may be removed by scratching, and raw surfaces remain from which clear fluid, perhaps mixed with blood, oozes. This is called an **excoriation.** Then the fluid dries and leaves the surface covered by a **crust,** which varies in colour, according as only clear serum has been present, or that fluid mixed with blood or yellow discharge.

Cracks or **fissures** are apt to be produced in the skin as a result of dryness or brittleness. The term **scar** or **cicatrix** is applied to the marks left after some loss of substance in the skin. The scar is a lower form of tissue which has been produced to make good the deficiency occasioned by the disease or injury. Thus in a deep wound the cicatrix is due to the new material formed between the lips of the wound to effect their union, and the cicatrix, that marks the site where an ulcer has been, is formed of new tissue attempting to take the place of that destroyed by the ulcerative process.

Scales are masses of cells from the horny layer of the skin shed as a result of some change in the deeper parts of the skin which has deprived them of nourishment. Thus scales are copiously shed in chronic inflammatory conditions of the skin. In scarlet fever and other acute diseases parts of the horny layer of the skin may separate in large masses. This separation of masses of cells of the epidermis, whether in the form of scales or in larger portions, is called **desquamation.**

DISEASES OF THE SKIN.

Inflammatory Affections.

Inflammatory Blush (*Erythema*). This is in the form of patches of a dusky red colour caused by increased flow of blood through the vessels of the part. Sometimes the patches are slightly raised above the level of the skin. In the simplest form the redness appears suddenly and vanishes suddenly, and is accompanied frequently by some degree of tingling. It occurs mostly on face and neck, arms, and trunk. After the redness has passed fine scales are separated. This is most often due to some digestive disorder. Another form is caused by rubbing of one surface of the skin upon another, as seen in children, and may lead to chapping of the skin. Frequent bathing is all that is necessary for this, followed by careful drying, and perhaps the use of glycerine or vaseline. In one kind of erythema occurring generally on the backs of the hands and feet, sometimes extending to the arms and legs, and seldom to the face, after the diffused redness has passed, pimples are perceived over the affected patch. They fade in a few days, and are not attended by any special symptoms. The most serious form of the disease is **Erythema nodosum** (see Plate IV.), in which dark red oval swellings from a half to several inches long, appear in crops over the front of the lower limbs in particular, and other parts of the body. The patches are hot and painful, but

not itchy. In a few days the red colour becomes livid, and then changes to yellow and green, like an ordinary bruise. Neumann states that children have been brought to him from schools, the teachers of which were accused of having beaten them, whilst really they were suffering from erythema nodosum. Loss of appetite, debility, feverishness, headache, &c., precede and accompany the disorder, which chiefly attacks young persons and females. It usually disappears after a few weeks. Some kinds of inflammatory blush are associated with rheumatism.

Treatment.—All that is chiefly required is attention to the diet and to the condition of the digestive organs. An occasional dose of saline medicine (Eno's fruit salt, citrate of magnesia, &c.), or to children fluid magnesia, is useful. To weakly persons acid and bitter tonics may be administered. In females some irregularity of the monthly discharges may be the cause of the trouble.

Rose-rash (*Roseola—False Measles*) is the name given to an eruption in which red patches appear on chest and neck, and sometimes on face and arms. They fade on pressure, but reappear on removing the pressure. Lasting only a few days, they soon fade, and often slight shedding of scales of the skin follows. Before and during the eruption feverishness, headache, and disturbances of digestion occur. The affection is apt to be mistaken for measles or scarlet fever, but it is not contagious. Only rest for a day or two is required in the way of treatment.

Nettle-rash (*Urticaria*, from *urtica*, a nettle). In this disease the eruption is characterized by wheals, which are at first red and spread, becoming then white in the centre (Plate IV.), The development of the wheals is accompanied by itchy stinging sensations, such as the sting of the nettle occasions. Fresh crops sometimes break out at intervals on different parts of the body, though each wheal quickly fades. The chest and back are more commonly attacked than the limbs. The face may be affected. For weeks or months the eruption may go on disappearing from one place only to appear on some other part, although it may last for only a few hours altogether. In some cases fever, shivering, headache, and vomiting attend the outbreak, in others these symptoms are absent. Nettle-rash may be excited by irritation of the skin, by bites of fleas, bugs, &c., by stings of various kinds, or by the application to the skin of substances like turpentine. It often arises from the taking of particular kinds of food, drink, or medicine, such as oysters, lobsters, fish, pork, sausages, cheese, cucumbers, mushrooms, copaiba, turpentine, &c. The presence of worms in the bowels, and in women irregularities of the monthly periods, pregnancy, &c., occasion it. Often no cause can be assigned for the attack. It is not contagious.

Treatment.—The bowels should at first be freely opened and thereafter well regulated. The diet should be carefully scrutinized. It is sometimes necessary to leave one thing out after another in order to discover whether the diet is causing the affection. Nor ought one to overlook the fact that gnats or bugs may be the exciting cause. All external sources of irritation of the skin should be removed, linen or cotton being worn next the skin. The person should be kept cool and be lightly clad. Cold sponging, and sponging with vinegar and water, relieve the irritation for a time. It is an affection, however, that very often resists all treatment.

Erysipelas (*St. Anthony's Fire—The Rose*) is an inflammation of the skin spread over a considerable area, not in patches. In it not only is there a temporary overfulness of the vessels of the affected part, but material passes from the blood-vessels into the substance of the skin. The part is not only, therefore, hot and red, but it is also swollen, and perhaps brawny. Usually it begins with a feeling of chilliness, headache, fever, quick pulse, furred tongue, and vomiting. The affected part is painful and itchy, and becomes red and shining. At first the redness is bright and disappears on pressure to return, but later it assumes a darker hue. In slight cases the redness fades in a few days, and the swelling disappears. It tends, moreover, to pass from one part to another. In more severe cases the swelling may be great, the colour becomes livid, and parts of the skin feel "boggy" to the touch, and may die and slough away, or abscesses may form. It often attacks the face, extending from one side to the other, and sometimes involves the whole head, causing subsequent loss of hair. In severe forms the pulse becomes rapid and feeble, breathing is hurried, and delirium occurs. Low, muttering delirium, tremulousness of the limbs, dry black tongue, and the passing of the contents of the bowels in bed, are bad signs.

Erysipelas is contagious. Specially has this been observed in hospital wards, and particularly in the surgical department, from its prone-

ness to start from a wound. In the wards of lying-in-hospitals it is a very serious disease, spreading rapidly and setting up puerperal fever. Persons who are not exposed to its influence through a wound or other raw surface, but who live in bad circumstances as regards diet, fresh air, and cleanliness, are also predisposed to be attacked, and if attacked are less able to overcome the disease.

Treatment should always be regulated by a physician, since the disease may rapidly assume a dangerous form. It is directed mainly to sustain the general strength, and consists chiefly in the administration of nourishing diet, beef-tea, eggs, milk, &c. The bowels should be regulated. The chief medicine employed is tincture of steel, of which 10 drops should be given in water every four hours. Stimulants are often necessary. Various applications to the affected part have been suggested. Dry cotton wool to exclude cold and irritation is perhaps best. Of course abscesses require opening. A patient who has recovered from an attack ought to exercise great care against its return.

Boil (*Furunculus*) is an inflammation of a small part of the true skin, usually beginning in the glands of a hair sac. The inflammatory material poured out causes a hard swelling, which is red, painful, and throbbing. Matter forms and appears at the top of the swelling as a yellow point. The matter bursts through and continues to be discharged through a minute opening for some time. Through the opening there may be seen deep in the part a yellow centre or "core." By the time this is loosened and discharged, the swelling and redness are greatly lessened, and the cavity fills up. When all tenderness and swelling have passed away a scar remains to mark the spot. In a "blind boil" the process is the same, but the boil is deeper and slower in reaching the surface.

A boil may be produced by some irritation applied to the part at which it appears. Usually, however, it is an indication of a depressed state of health, particularly if one occurs here and another there at intervals, or if crops of them break out.

Treatment.—One may be successful in checking the development of a boil in its early stage when it is felt as a hard painful spot in the skin by the application of some soothing substance, such as a paint made of equal parts of glycerine and extracts of opium and belladonna. When the boil is hard and stinging hot applications are most soothing. They are, however, apt to bring out pimples round the boil, which may themselves develop into boils. To prevent this it is well to cover the surface of the skin for some extent with adhesive plaster, an opening being cut in the plaster opposite the top of the boil. It often hastens cure, and aids in the removal of pain, to have a surgeon freely open the boil with a lancet. Besides such local treatment the patient's bowels should be relieved by seidlitz-powder or similar medicine, and nourishing food, quinine and iron tonic, &c., should be administered.

Carbuncle (*Anthrax*) is an inflammation of the true skin and tissue beneath it akin to that occurring in boils. It is more extensive than the latter, and instead of one has several cores. Considerable portions of the skin are apt to be destroyed and to separate as sloughs. It is associated with a bad state of general health, from which condition its danger arises, for it may threaten life by exhaustion. It begins as a painful hard swelling, increasing in size, and deepening in colour, situated most commonly on the back of the neck. The pain is severe and throbbing, and fever is marked. In a few days several openings are formed on the surface, from which discharge escapes, and through the openings yellow "cores" are seen. The skin becomes undermined, and the openings unite to form a large one, revealing an ashy-grey slough in the deeper parts. As this is discharged a cavity is formed extending some distance under the skin. Often pieces of the skin die and are thrown off, so that a large ragged wound is formed, from whose surface shreddy matter separates. The exhaustion is often great, and extensive parts of the skin are more liable to die because of the general weakness.

Treatment. — Nourishing and stimulating diet is of the utmost consequence. Quinine and acid tonics (see PRESCRIPTIONS) are to be given. The local treatment is similar to that prescribed for boil. Carbuncle is frequently fatal from exhaustion or blood-poisoning, and from the first a competent surgeon should have charge of the case.

Ulcers of the skin are common. An ulcer implies that the skin is broken, and that there is loss of substance. Owing to softening and breaking down of the skin an open sore exists. Various circumstances may encourage the formation of an ulcer. Thus some persons may be in such a depressed condition of health that the slightest scratch or bruise will lead to breach

of the surface and the formation of an ulcer. Again, while the general health may be of a fair average, some particular part may be subject to influences that readily provoke ulceration. Thus persons who suffer from enlarged (varicose) veins are liable to have ulcers forming on the legs on slight provocation. Owing to the dilated veins the circulation is so sluggish that the nourishment of the skin is impaired, and a scratch or knock or bruise gives rise to a sore difficult to heal. Such ulcers occur often in persons who have to stand most of the day, laundresses, cooks, &c., specially if they are stout of build; and the ulcers are on the legs because these are the lowest parts, from which the return of blood is most impeded.

Ulceration may find its starting-point in a cut, bruise, or wound of any kind.

Ulcers heal by what is called **granulation.** The broken surface is covered over by minute red elevations (the granulations) or hillocks of newly-formed tissue, which readily bleed. From the surface fluid oozes away, consisting partly of a clear fluid (serum) and partly of matter (pus). By the growth of the granulations the loss of substance is gradually made up. Round the edge of the sore there is a slow encroachment of the upper layers of the sound skin, so that the extent of the sore gradually diminishes, and a thin covering of scarf-skin spreads over it. Ultimately the sore is entirely covered over, but retains features distinguishing it from normal skin—its thin covering, not of true skin, and its pale transparent appearance. In medical language a cicatrix or scar remains.

There are various kinds of ulcers. The late Professor Syme of Edinburgh classified them as—1. *Healing ulcers*, 2. *Ulcers failing to heal from excess of action*, 3. *Ulcers failing to heal from defect of action*, and 4. *Ulcers failing to heal from peculiarity of action.* It is often a nice point for a surgeon to decide what kind of ulcer he is dealing with, and what is the appropriate treatment. The probability is that an unskilled person, attempting to cure an ulcer, will only aggravate the sore. Here we shall only try to indicate what such a person may do, in the absence of proper surgical advice, without running such a risk.

1. The **healthy ulcer** is known by the small, firm, red elevations that cover it. They are sensitive when touched and readily bleed. There is a slight discharge of healthy matter. The edges are level with the surface, and a thin blue line indicates the advancing layer of skin.

The **treatment** of this kind of ulcer consists simply in giving it fair-play. Let the part be kept at rest and raised—not hanging. Let the part be cleaned by allowing pure tepid water to flow over it from above. Cover it with a piece of lint wet with clean water, and over the lint place oiled silk, the whole being retained in position by a well-adjusted bandage. The person's general health should be maintained.

2. The **ulcer failing to heal from excess** of action has red, swollen, angry-looking edges, uneven surface, and thin offensive discharge, and there is aching or throbbing pain.

Treatment.—Raise the part affected and ensure rest. Let the person's bowels be opened by such medicine as seidlitz-powder, and let attention be given to the patient's health. To the ulcer itself apply warm bread poultices to relieve the pain and swelling. If this is not sufficient, a lotion, made of $\frac{1}{2}$ ounce of solution of acetate of lead and the same quantity of glycerine to 5 or 6 ounces of water, may be applied, on lint covered with oiled silk. When the irritation has passed the treatment for healthy ulcer is to be adopted. Irritable ulcers in full-blooded people, who live "not wisely but too well," will be greatly helped by the free use of seidlitz-powders, or mineral waters like Hunyadi Janos.

3. The **ulcers failing to heal from defect** of action have flabby, large granulations, to which the term "proud flesh" is applied. The discharge is thin and watery, and the ulcer is painless. In other forms the surface is glazed, no granulations being present, and the edges are raised, hard, and irregular.

Treatment.—Those exhibiting "proud flesh" are best treated by firm pads placed on the surface and kept there by moderately-firm bandaging. Under the pads an astringent dressing may be applied. For that purpose a solution of 2 grains of chloride of zinc in an ounce of water may be used, diluted if found advisable. The same solution is valuable for the glazed ulcers. The patient should have nourishing diet and quinine and iron tonics.

4. **Ulcers failing to heal from peculiarity** of action are of various kinds. They may be due to syphilis, scurvy, scrofula, &c., and as a rule their treatment consists of treatment of the constitutional condition which maintains them, which it is the business of a surgeon to detect. Belonging to this class also are ulcers caused by dilated veins, occurring commonly on the legs. Anything that supports the veins will help the ulcer, notably a well-adjusted elastic stocking.

Ulcers prevented from healing by some constitutional state are often sloughing ulcers, whose edges rapidly break down, are very irregular and undermined. It is to be noted that in the simple suggestions for treatment given here no mention is made of the use of bluestone or caustic. These are sometimes used by surgeons, and if used judiciously may often be of great value, but should never be taken into the hands of any one else.

It is not to be assumed that one or other of the methods noted will be sure to heal any ulcer. Many ulcers are extremely obstinate and baffle even skilful surgeons. But what it is desirable to insist on is that, if people must treat ulcers on themselves or others without medical advice, such simple means as are mentioned are the only safe methods. In all cases if after a few days' trial the person fails to produce an improvement in the sore, he should seek advice whenever possible.

Herpes is the name given to an eruption characterized by groups of small sacs (vesicles) filled with a clear fluid. An itching or burning sensation announces the approach of the eruption, and the same sensation accompanies it. The part of the skin attacked is swollen and inflamed before the vesicles form. Two or three days after the eruption is fully formed the clear fluid becomes turbid, and finally dries up into a crust. It lasts not more than 7 or 8 days. The eruption may occur on the lips, on the lining membrane of the mouth and tonsils, and rarely the tongue, and on various other parts of the body. It may occur on the private parts. In all its forms it is accompanied by some slight disturbance of general health, fever, headache, &c.

Perhaps the commonest form is that which occurs on either the upper or lower lip during an ordinary cold, and called **herpes labialis**, herpes of the lip. It is familiarly known to everyone as one of the signs of a cold. When they occur on the throat they form little ulcers by the bursting of the vesicles.

Another form is apt to occur in young people at particular times of the year in the shape of clusters of the small blisters about the elbows and knees and other parts.

Treatment.—Painting the part when the tingling sensation begins with tincture of camphor may check the eruption; but once it is formed it should be left alone.

Shingles (*Herpes Zoster*) is an eruption of the same kind as that just described. It is, however, much more extensive, and it attacks in particular certain well-defined parts of the body. It seems to have a nervous origin, for it follows the course of some particular nerve. Thus it is common on one side of the chest, from the middle line of the back round to the middle line in front, but not crossing that line. This is the course of one of the nerves running between the ribs. It may occur on both sides, not by extending itself, but because it attacks two different nerves. This, however, is rare. It may occur over the belly in the same semicircular way, also over the cheeks and nose, or over the forehead from the inner corner of the eyelid, following the line of one of the sensory nerves of the face; and in other localities.

It is preceded by stinging neuralgic pains for 24 or 48 hours, then the eruption comes out in numerous groups (Plate V.) over the inflamed skin, and is attended by intense irritation. The eruption goes through the same stages as already noted of ordinary herpes, and yellow crusts form. The vesicles attain their full development in 5 or 6 days, and in 8 or 10 days usually the eruption has disappeared. Sometimes successive crops delay the disappearance. Often, especially in the aged, the pain does not cease with the disappearance, but may continue for weeks and months. It does not recur.

Treatment.—No known treatment is of any use to check the disease. It must be allowed to run its course. All that should be done is to diminish the irritation as much as possible by dusting the part with powder, and covering it with cotton wool, held in position by a bandage, to prevent rubbing with the clothes. Sometimes the pain is so great that it is necessary to give doses of opium to relieve it and to procure sleep. When the neuralgic pain continues quinine, iron, and arsenic tonics are valuable. (See PRESCRIPTIONS—TONICS).

Pemphigus is a disease of the skin attended by the formation of blebs (bullæ). These are like blisters, larger than vesicles, varying in size between a millet-seed and an apple, and are filled with a clear yellowish or muddy fluid. The skin on which they rest is slightly inflamed. They come out in successive crops over various parts of the body, except the head, palms of the hands, and soles of the feet. The fluid of the blebs may be absorbed, and the skin over the collapsed sac becomes dry and separates, or the bleb may burst and leave an exposed surface.

Acute cases of the disease occur rarely in

adults, but not unfrequently in children. They run their course in three to six weeks without much constitutional disturbance being produced, unless the blebs are large and in frequent crops, when the itching becomes very severe. Only in ill-nourished children, when the eruption is extensive, need any fear of the result be entertained.

Treatment.—Nourishing and generous diet is of great importance. The principal medicine to give is arsenic, but so much caution is necessary for its administration that it should be left entirely in the hands of a physician. Quinine and iron tonic may be given. The skin is to be frequently bathed.

Eczema (*Moist Tetter—Running Scab*—see Plate IV.) in its beginning consists of an eruption of pimples or vesicles or pustules on inflamed and swollen skin. The vesicles burst or are torn by scratching, and a red weeping surface is produced. The gummy fluid from the torn surface may dry on the inflamed part and crusts be produced. If the crusts be removed the dull red surface becomes dry and covered with white scales. Thus the appearances presented by the part affected with eczema may vary with the stage of the affection. There is usually intense itching, and the scratching that is occasioned leads to an extension of the disease. The chronic forms of eczema are the most common, but acute attacks are also frequent. They may last not more than a fortnight, or may return in successive attacks, and finally pass into the chronic type. A sense of chilliness along the back and feverishness usually precede the acute form; the skin becomes red and swollen, and within 48 hours the eruption appears, which, in a week or ten days, passes through the various stages described. In chronic cases the place affected has often something to do with the appearances produced. In eczema of the head the oozing fluid from the inflamed surface, mixed with secretion from the glands of the hair, readily forms matted crusts among the hair; and, if the part is not kept clean, the condition may spread till the whole scalp is affected. Moreover, in the offensive mass lice, maggots, &c., breed. This is common among ill-nourished unhealthy children (is termed **scald-head** or **milk-crust**), and may last for years if not treated. When the scabs are removed a red thickened surface covered with scales is laid bare. The disease easily extends to the lobes of the ear and into the canal of the ear in the form of red cracked skin, weeping or scaly, or coated with scabs. The nostrils may be affected and their openings plugged with thick scabs, the skin of the lip being red and swollen. Eyelids and eyebrows are often involved in the disease.

Eczema also occurs on the surfaces of joints, particularly the knee-joint, or the surfaces on which the limb moves when bending takes place. Owing to the frequent movement painful cracks are formed, and the skin is red, thickened, and crusted. A similar form occurs on hands and feet. That of the feet is ascribed to the pressure of boots, and is on the back of the foot usually; that of the hands is commonly due to irritating substances among which the person works. Thus **grocer's and baker's itch** are forms of eczema, occurring on the hands and arms, and set up by working among salt, sugar, &c., and by the action of heat and moisture. In eczema of the genitals itching is severe and leads to much scratching and tearing. The surface becomes red and thickened, and the affection may extend downwards along the thigh, upwards towards the abdomen, and back to the anus, where it may lead to the formation of painful itching fissures.

Eczema may be caused by the direct action on the skin of irritating agents, examples of which have already been given. Mere scratching will sometimes be sufficient to produce it, the pressure of clothes, &c. It also results, however, from constitutional conditions.

Though eczema is curable, relapses are very common.

Treatment.—Eczema is treated chiefly by applications to the affected part, and not by drugs administered internally. It is a common notion, but quite a mistaken one, that the cure of the disease, so far as it affects the skin, will tend to "drive it inwards" on some more important organ. No such idea ought ever to be permitted to stand in the way of adopting appropriate methods to obtain a cure. A great variety of preparations are adopted, and many cases are very obstinate. It is, therefore, necessary to have the treatment guided by a surgeon. The following simple directions may, however, be found useful. In the stage of swelling and heat cold-water dressing will afford relief. After the eruption has appeared dusting with finely-powdered starch, white oxide of zinc powder, or chalk, may be tried. Scabs should be removed after softening with oil, or bread-and-water poultice, or, perhaps best of all, poultices of mashed turnips. These latter are specially valuable in eczema of the scalp. When the scabs have all been removed simple ointments

like vaseline may be applied. A very valuable ointment is made of the yellow oxide of mercury (yellow precipitate) 1 drachm, oil of sweet almonds 1 drachm, lard 6 drachms. This ointment may be applied to the eyes as well as to any other part. For eczema occurring on two surfaces that rub on one another careful bathing and drying, and then the application of vaseline are sufficient. In particular *all irritating applications are to be avoided.* If the person suffer from depressed health it is advisable to use quinine and iron tonics, and to obtain change of air.

Psoriasis vulgaris (*Diffuse Dry Tetter*—see Plate V.) is a chronic disease of the skin, in which thick layers of shining pearly scales are formed on a reddened and thickened skin. The scales are easily separated by the nails. There is little or no itching, and thus, in one chief point, psoriasis differs from eczema. Large portions of the skin may be affected, or the eruption may occur in little heaps, of the size of pin heads, which gradually enlarge till masses like drops of mortar are produced, and still enlarging may become like coins in size. These patches tend to heal in the centre and spread at the circumference, circles and figures of 8 being produced. As the disease heals the patches become less raised, the scales being detached, and others not being formed with the same rapidity, and the redness gradually fades till the skin resumes its natural colour. The most common places for psoriasis are the backs of the elbows and the front of the knees. It may also form a ring round the forehead and ears.

Psoriasis may be cured, but is always liable to return. It is not contagious, but is distinctly transmitted from parents to children.

Treatment.—The most successful application is made of a powder called chrysophanic acid, of which 15 grains are combined with 1 ounce of lard or vaseline. This may be rubbed on the part at once, or after scales have been removed by the use of soft soap. If it irritates too much the ointment may be weakened or discontinued for a time. It stains clothing a deep colour, not removed by ordinary washing. Benzole, however, or a weak solution of potash or chlorinated lime will remove the stains. It is commonly necessary to combine with the ointment the internal administration of arsenic. A good way of avoiding a mistake with the dose is to have the drug put up in pill, each pill containing 2 grains dried sulphate of iron, $\frac{1}{10}$th of a grain arseniate of soda, and 1 grain extract of gentian. One pill should be taken thrice daily *after meals.* The pills should be continued for a long period, *should never be stopped abruptly,* but when it is desired to cease taking them, the dose should be gradually diminished, $2\frac{1}{2}$ pills daily, then after some days 2 pills daily, and so on, till, after the lapse of a fortnight or so, the dose has been gradually reduced to nothing. *On the whole, however, such drugs should not be taken without the direction and guidance of a physician; and no one, of course, would give such a medicine to children unless the correct dose were regulated by a medical man.*

Dandruff (*Branny Tetter—Pityriasis*) is a chronic disease of the skin, in which a quantity of fine scales is continually being produced and shed. The skin is sometimes slightly red, and there is some amount of itching present. Any part of the skin may be affected, but the scalp is specially apt to be the seat of the disease, chiefly in children and old persons. It is a very chronic affection. The distinguished German authority on skin disease—Hebra—has shown it to be really due to excessive secretion of the glands connected with the hair follicles—the sebaceous glands (p. 308).

Treatment.—A free use of soap is advised or the use of an alkaline solution, such as the carbonate of potash (salt of tartar) of the strength of 60 grains to the half-pint of water. An ointment consisting of one part of red precipitate ointment and three of lard is useful for the scalp.

Impetigo, Plate V. (*Pustular Tetter—Honey Sickness—Honey Scab*). This is an inflammation of the skin in which a flattened eruption containing matter is formed. The matter soon dries up and leaves yellow crusts or scabs. When the scabs are removed a raw surface is left. Heat and itching are severe. It occurs on the face and head and sometimes on the hands. It is accompanied by feverishness and sensations of chilliness. The disease runs its course in about a fortnight, but may be prolonged by successive crops. The matter of the pustules is capable of producing pustules on healthy parts by being inoculated.

Treatment.—Remove the scabs by the use of oil and poultices. Thereafter the ointment recommended in the immediately preceding article, with the addition of 20 drops of carbolic acid, well mixed, is to be applied to the affected parts.

Lichen Simplex, Plate V. (*Strophulus—Red-*

gum Rash). Lichen is characterized by an eruption of minute red pimples, which last about five or six days, are accompanied by much local irritation, itching, and tingling, and sometimes constitutional disturbance such as headache and feverishness, and whose disappearance is followed by slight shedding of scales of the skin. The pimples are solid, that is contain no fluid, and make the skin feel very rough. The face or arms are usually affected, but other parts also. The tops of the pimples may be torn off by scratching, and a minute crust of blood may cover them, altering the appearance of the eruption. The eruption may be mistaken for measles.

Strophulus, Red Gum, or Tooth Rash, appearing in infants, is similar to the eruption of lichen, and has been classed with it.

Treatment.—Mild opening medicine should be given, to children fluid magnesia. Tepid baths are of great use in allaying irritation, and should be frequently employed. All irritating agents should be removed from contact with the skin. Thus flannel should not be worn next the skin. Plain diet, milk, &c., is the most suitable. Internal remedies are sometimes necessary, but these should be prescribed by a physician.

Overgrowths, New Growths, and Hæmorrhages.

Barbadoes Leg (*Elephantiasis Arabum*) is so named from its frequent occurrence in Barbadoes. It is common in hot climates—the West Indies, India, Arabia, Egypt, China, and the west coast of Africa.

It consists of an overgrowth of the skin and connective tissue, attended by inflammation, and involving blood-vessels and lymphatics. The parts usually affected are the legs or the genital organs. The skin is so greatly thickened and thrown into folds, and the feet and toes are so masked, when the leg is affected, by the enormous overgrowths, that the appearance of an elephant's leg is produced, hence the term elephantiasis. When the genital organs are affected, tumours of great size may be formed, reaching down towards the knee or beyond it. Tumours of this kind weighing 100 pounds have been removed by operation.

Symptoms.—The disease begins by attacks of fever occurring at intervals, like attacks of intermittent fever, and accompanied by inflammation and swelling of the affected part. When it occurs in the genital organs these parts are swollen, the pain is often intense, passing up the groin, and accompanied by vomiting and other signs of constitutional disturbance. The lymphatics may become dilated, forming blebs from which lymph may escape. With the recurring attacks the overgrowth of the skin gradually occurs, until the great size and remarkable appearances already noted are produced. Large ulcers are sometimes formed in the skin, from which a foul discharge escapes.

The **cause** of the disease is not understood. Some are disposed to regard it as hereditary, while others are disposed to regard it as an affection of lymphatic vessels. Large numbers of a parasite (the *filaria sanguinis hominis*—see p. 238) have been found in the blood of those suffering from it. Climate, there is no doubt, has much to do with it—many believing it to be due to malaria—and the removal of the person from the place where the disease prevails, if accomplished in the earliest stages, is one of the best means of treatment. Men are equally liable to it as women, but it rarely attacks before puberty.

Persons may suffer from elephantiasis for years without the general health suffering, the increased growth being arrested, or slow overgrowth going on without recurrence of fever. The progress of the disease may thus be slow.

Treatment.—It is sufficient to state here that the best thing is to remove the patient from the district to some place where the disease does not occur. Europeans who contracted the disease in India have recovered on returning to Europe. Removal must, however, be very early. The tumour may be removed by surgical operation, and this should always be done where it occurs on the genitals.

Fish-skin Disease (*Ichthyosis*) is an affection in which there is an enormous overgrowth of the scarf-skin. The true skin is also thickened. Furrows are deepened, and thus the skin is mapped out into irregular areas, and the appearance of crocodile's hide produced. Masses of the overgrown cells may vary in colour, being of a pearly colour, or varying to brown and black. The disease is usually most marked over elbows and knees. Sometimes the only inconvenience produced by it is slight itching. The disease may be transmitted from parent to child, and commonly becomes apparent in the child at about two years of age. It is not fatal, but does not easily yield to treatment, though it may be improved for a time.

Treatment consists in frequent warm baths,

and rubbing the skin with oil, soft soap, &c., to soften and remove the scaly masses.

Leprosy (*Leprosy of the Jews, Lepra, Elephantiasis Græcorum*). This is the leprosy spoken of in the Bible, and is to be distinguished from Elephantiasis Arabum—Barbadoes Leg. It was at one time prevalent in England and Scotland, but is now extinct. It flourishes in Norway and Iceland, the coasts of the Black Sea and Mediterranean, in Madagascar, Mauritius, Madeira, the Greek Archipelago, East and West Indies, Palestine, &c.

It is probably contagious, though that is not certain. At anyrate, it is transmitted from parents to children, more frequently by the mother than the father. It usually commences in early adult life. It seems to have arisen in marshy districts on the banks of the Nile; and it was at its worst during the Crusades of the eleventh and twelfth centuries.

Three varieties of leprosy are described. One form is spotted leprosy, in which reddish coppery spots appear on the skin, and are met with on the mucous membrane of the mouth, throat, nostrils, and eyes. They spread at the margins, and after a time become paler at the centre, smooth, and shining. The redness may disappear and leave a bronzed stain or an unnatural whiteness. This form may exist for a long time, appearing and disappearing. The reappearance is frequently preceded and accompanied by fever, a feeling of languor, dulness of spirits, chilliness, and a general feeling of illness. The second form is a more advanced stage. The patches are no longer discolorations of the skin, but are raised, and form tubercles, thickenings in the skin, varying in size from a small shot to a nut. They appear specially on the hands, arms, and feet, and on the face. A remarkable alteration is produced in the appearance by them. Along the eyebrows the tubercles produce a frowning look. The hair of the eyebrows falls out, a thickened nodulated appearance of the whole face results from tubercles over nose, cheeks, chin, and lips, so that a lion-like ruggedness is imparted to the face. Hands and feet become deformed; abscesses and ulcers form; fingers and toes may be lost by death of the parts. Hair disappears from the affected patches, and nails become cracked and distorted. In the third variety patches of skin become insensible, but surrounded by over-sensitive regions of skin. Wasting of the skin sets in, and wasting of muscles and bones. The fingers are remarkable for thinness. As a result of wasting deformity and mutilation are produced. The early stage of this variety is characterized by the formation of blebs on the skin, which burst and leave behind inflamed and ulcerated surfaces. When the ulcers heal, white, smooth, depressed scars, without hair and deprived of sensitiveness, remain. The various kinds of the disease may be seen on one individual.

Leprosy is a fatal disease, though it may be slow. Death may arise from exhaustion or affections of lungs or bowels. The tubercular form lasts on an average eight or ten years, and the form attended by loss of sensation (the anæsthetic form) may last for twenty years.

Treatment consists in removing the person from the district where the disease prevails, in strict cleanliness, in attention to diet, &c. The general health is to be maintained by nourishing food, tonics, exercise, fresh air, &c. Cod-liver oil, and various other kinds of oil, have been used, and may be used, but are of little value, except as they help the general strength.

Lupus (*Noli me tangere*). The term *lupus* means a wolf, and has been applied to this disease because of its destructive tendency.

It consists in the formation of little groups of cells in the substance of the skin. The nodules thus produced may soften and break down, so that ulceration is produced; or the new growth may, after a time, disappear; but absorption of the tissue around occurs, and, owing to the loss of substance, depressed white scars occur. In the common form (**lupus vulgaris**) dull red nodules, resembling reddish transparent jelly, and of the size of a pin's head or a small shot, occur in groups or scattered in the skin. They slowly increase in size and number, sometimes forming tubercles by joining. They may remain without change for a long time, and then slowly disappear, leaving a white scar lower than the level of the rest of the skin. As the nodules disappear at one part, they appear beyond, and so a considerable extent of skin may be destroyed. They occur most frequently on the face and nose.

The nodules may ulcerate, and lead in this way to great loss of the skin and structures beneath it. As the ulcer slowly heals in the centre it spreads round the margin by formation of new nodules, which in turn break down. The nose is often destroyed in this way.

Another form—inflammatory (*lupus erythematosus*)—occurs upon the face and head, appearing as a red patch on the nose, and later as

red patches on each cheek. Spreading gradually at the margin, the patches unite and produce a "butterfly" appearance, their centres becoming whitish, shrunken, and flat.

The disease attacks the wrists and trunk as well as the face, is most common between the ages of two and eighteen, tends to disappear with age, and is more common in women than men. It is not contagious. It is very tedious and very difficult of treatment.

Treatment consists in the administration of nourishing food, tonics, cod-liver oil, and in the use of caustics and other means for destroying the growth.

Freckles are brown spots of various degrees of darkness, which occur on the skin of fair people, particularly on the exposed parts, such as face, neck, wrists, and hands. The action of light brings them out, and in summer they are specially dark.

Treatment.—The best application is a lotion of bitter almonds, made by pounding up twenty bitter almonds into a paste with water, adding water to 5 ounces, and dissolving in it 2 grains of bichloride of mercury. This is very poisonous, and ought so to be labelled. The lotion is applied with a soft sponge and allowed to dry on.

Sunburn (*Tan*) consists of irregular patches of discoloration produced by the action of the sun's rays. The lotion advised for freckles is good for it.

Cloasma, often called *liver spots,* formed of patches of a pale or brown-yellow, occurs specially on the face, neck, and trunk. It is common in pregnant women. The lotion of bitter almonds may be used for this as for freckles.

Moles (*Mother's Marks, Nævi*) are spots or patches which, in some cases, consist simply of skin with excessive deposition of colouring matter, and in others of masses of dilated fine blood-vessels. For the latter see p. 247. The former kind is sometimes covered with long hairs. If it is not situated on an exposed part, the mole should be left alone. If it disfigures it may be touched from time to time by glacial acetic acid, applied by a fine brush, care being taken that no acid comes in contact with sound skin. Even should this destroy the mole, a scar will always remain. A surgeon might be able to cut it out so as to leave less of a mark.

Warts are small outgrowths of skin with its covering of epidermis. They are hard when over ordinary skin, soft when on mucous membranes, such as that of the lips and private parts, or on skin kept moist. Glacial acetic acid, used as directed for moles, is the best application. Sometimes they come out rapidly in crops, and sometimes suddenly begin to disappear.

Corns are formed by excessive growth of the cells of the epidermal layer of the skin, excited by overpressure on the part—the pressure of a tight boot, for example. The pressure of the accumulated mass of cells causes wasting of the skin beneath it, and thus the corn comes to lie in a sort of pit.

Treatment.—The feet should be frequently bathed in warm water to soften the corns, which are then rubbed down with a file or pumice stone. To protect the part from undue pressure a corn plaster is put on. It consists of a soft circular or oval pad of cotton fixed to adhesive plaster on one surface, and with a hole in the centre. The plaster is placed so that the hole is directly over the corn, and so protects it. But prevention is better than cure, and if boots of a proper size and well fitting are always worn, corns will not readily form. Soft corns, which occur between the toes, are easily destroyed by the application of glacial acetic acid.

Horns, consisting of curved brownish masses of epidermis, sometimes occur on the head. They should be cut out.

Purpura Hæmorrhagica, in which deep red spots of various sizes appear on the skin, usually of the legs, is rather a constitutional than a skin disease, and is described on p. 237.

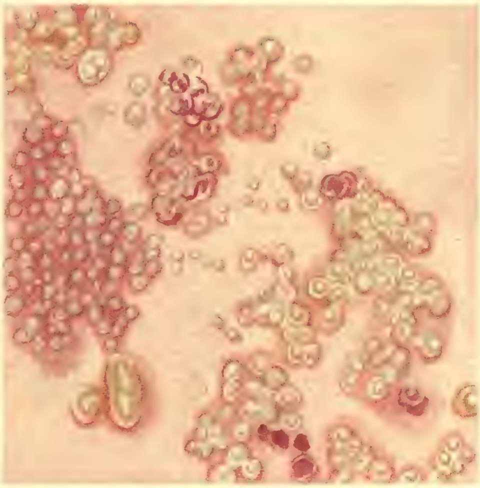
Cancer is common in the skin and mucous membranes, in the form of epithelioma or skin-cancer. This is formed of an enormous increase of epithelial cells similar to those of the epidermis, which exist as hard nodules in the skin, slightly raised above the surface. In time an ulcer is formed, with prominent, irregular, and hard edges, with an irregular warty floor, and discharging thin unhealthy matter. Its commonest place is on the lip, and it rarely occurs under forty years of age. It is also met with on the face and on the external genital organs. If not removed early, the disease spreads to lymphatic vessels and glands. Moreover, the disease spreads in all directions in the immediate neighbourhood by multiplication of the cells, and the ulcer spreads by breaking down of the new growth.

In women cancer involving the skin of the

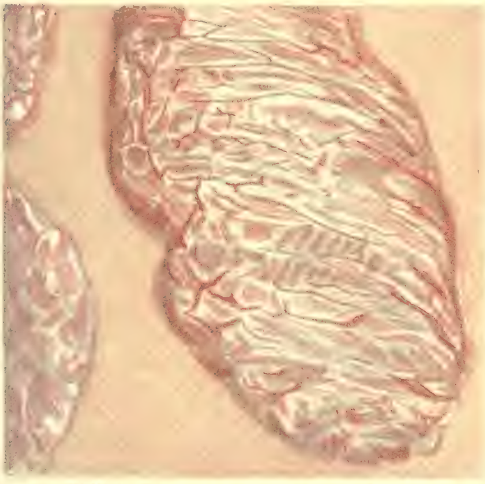
Scabies or Itch. p.[illegible]

Red Gum, Rash, Simple Lichen or Spotted Heat. p.319.

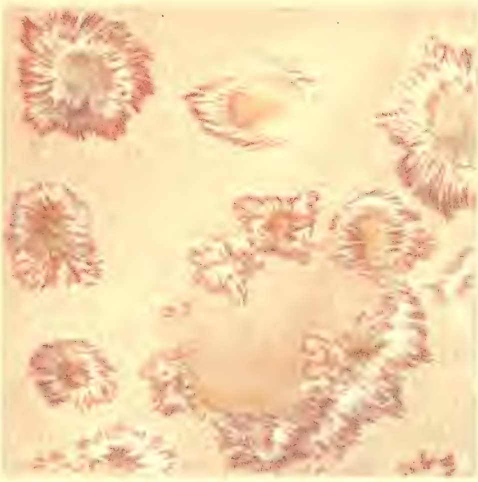
Honey Sickness, Honey Scab, or Pustular Tetter.
Impetigo. p.[illegible]



Shingles — Herpes Zoster. p.317.



Diffuse Dry Tetter — Psoriasis vulgaris. p.[illegible]



Another form of Psoriasis — Circular Dry Tetter. p.[illegible]

breast is common, specially between the ages of thirty-five and fifty-five. **Chimney-sweeper's cancer** is the epithelial form occurring in the external genital organs.

The proper **treatment** is removal by the knife; and if this is done early and thoroughly there is good hope of the disease not returning.

Itching Diseases and Diseases due to Parasites.

Itching (*Pruritus*) is a condition of perverted sensibility of the skin. It is not to be regarded as a disease in itself, but merely as a symptom of a disease, and it may accompany various disorders. Itching may be present in a very annoying degree without any eruption of the skin at all. But if it is severe, and lasts for any time, the mere mechanical injury, inflicted by the nails of the person, is likely to produce considerable changes in the appearance of the skin, in the shape of scratches, tender and bleeding spots or patches, from which the protective scarf-skin has been removed, and inflammation and thickening of the affected parts. If the itching attends an eruption the characters of the eruption are considerably altered by the tearing, the tops being scratched off pimples, which are thus made to bleed, and then the blood dries and forms a red crust or cap to the pimple, &c. The itching may be confined to parts of the body or may be spread more or less over the whole body.

1. Itching is very often due to the presence of the itch insect (see THE ITCH) or the louse (see LOUSINESS, p. 324), or to the parasite of ringworm (see RINGWORM, p. 326).

2. It may be caused by the irritation of rough clothing.

3. It may arise because of inflammation of the skin. Thus eczema (p. 318), lichen (p. 319), and sometimes psoriasis (p. 319) and pemphigus (p. 317), are accompanied by itching.

4. It may be due to constitutional and various other diseases. Thus an intense itching about the private parts is often caused by diabetes (p. 303), even in cases where no other symptoms lead to the suspicion of that disease. Itching about the anus is frequently the result of piles. In jaundice the retention of certain biliary constituents in the blood produces itching of the skin. Irritations of the intestinal canal, caused, for example, by worms, irritative affections of the womb, and affections of the kidney and bladder, may lead to it. In old people changes in the skin, resulting from old age, may cause it.

5. Certain drugs, such as opium and copaiba, after being taken inwardly, tend to produce a general itchiness of the skin.

Treatment.—As soon as the cause has been found the remedy may be easy. Insects should be destroyed, disease of kidney, womb, &c., should be treated, irritation removed if possible, and so probably the itching will disappear. Where no cause can be discovered tonics (iron and quinine) should be given; the person should not wear flannel next his skin, and frequent bathing with water in which ordinary soda is dissolved should be resorted to. A lotion is also recommended consisting of Wright's liquor carbonis detergens, ½ ounce in 8 ounces of water, and 1 ounce of glycerine. With this the parts should be sponged.

The Itch (*Scabies*). This is an itching disease due to the irritation of the itch insect (**acarus scabiei**), in which the skin is inflamed (Plate V.)

The male itch insect is represented in Fig. 147. It is just large enough to be seen with the naked eye, has eight legs, and a number of projecting spines from its under surface. The female is slightly larger than the male, being about $\frac{1}{80}$th to $\frac{1}{60}$th of an inch long, and on the ends of the four front legs it has suckers, while the hind-legs end in long hairs. In the male two of the hind-legs have suckers.

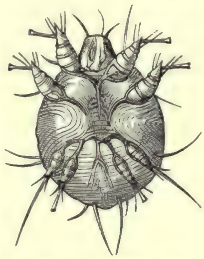


Fig. 147.—The Male Itch Insect (magnified).

When the female is placed on the skin it bores its way into the epidermis, and, after lying embedded for a little, lays an egg. To make room it bores a little further along, then lays another egg. Daily a fresh egg is laid, the insect meanwhile advancing and penetrating into the skin till it has bored a tunnel, which passes more deeply into the skin the further it is carried. With the growth of the skin and the shedding of the cast-off cells of the epidermis, the tunnel is brought nearer to the surface, till the first egg is exposed, about the time it is hatched. Fourteen days usually elapse between the laying and hatching of an egg. In one tunnel there are about fifteen eggs. The young insect has at first only six legs, two of the hind-legs being wanting till after it has shed its first skin. The young insects escape from the burrow to the surface of the skin. The females meet males, become impregnated, and proceed themselves to

burrow. The adult female insect dies at the end of her tunnel. The male insects run about on the surface. Fig. 148 represents a female acarus at the end of its burrow and a series of eggs behind it.

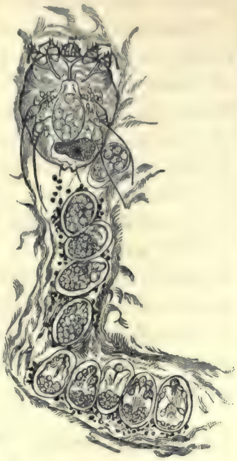


Fig. 148.—Itch burrow with female Itch Insect at one end and the eggs behind (magnified).

Symptoms. — The disease usually attacks the webs between the fingers, the front of the wrists and elbows, and the lower part of the belly, the nipple in the female, the buttocks and the genitals. The feet and legs are attacked in children. There is intense itching, worse at night, or whenever the person becomes warm. The scratching induced, as well as the irritation excited by the burrowing of the parasites, leads to a scattered inflammation of the skin; swollen lines, pimples capped with crusts of dried blood, blisters and pustules are formed. The chief thing to be looked for is the burrow, which is like an old pin-scratch. It is irregular in shape, from half a line to 3 inches long, with a whitish dotted appearance, the dots being the eggs, and a little mound at the deep end, where the adult acarus lies. If all the canal has been opened up it may simply appear as a dirty ragged line.

Treatment is simple and effective. The affected person should take a hot bath, and should thoroughly scrub the whole body, except the head, with soap and water. Persons with thick and not very sensitive skin may use soft soap. After the bath the whole body, and especially the parts where the eruption is, must be well anointed with sulphur ointment, either the simple or compound sulphur ointment of druggists. The ointment should be well rubbed in. If it is properly done, one application is sufficient. An ointment may be made of subcarbonate of potash (1 drachm), sulphur (2 drachms), and lard (12 drachms). In the morning after the use of the ointment a warm bath should be taken. To destroy insects on the person's clothes they should be steeped in boiling water, or exposed for some time to air at a temperature of 150° Fahrenheit, or ironed thoroughly all over with hot irons.

Lousiness (*Phthiriasis*). Three kinds of lice may be harboured on the human body—the head-louse (*Pediculus capitis*), the body-louse (*Pediculus corporis*), and the louse found on hairy parts except the head, and specially on the pubis—the crab-louse (*Pediculus pubis*), each kind limiting itself to its special region of the body. The **head-louse** is shown in Fig. 149. It has a body of seven segments, an oval head, provided with feelers (antennæ), and six legs, three on each side, which are hairy, and terminate in claws. The head has two simple eyes, and is provided with biting and sucking apparatus. The animal is able to bite into the skin and then to insert its proboscis into the wound in order to suck blood. The head-louse confines itself to the scalp, running about amongst the hairs, where it is capable of multiplying with great rapidity by means of eggs. The eggs (nits) are firmly attached to the hairs by means of sheaths, and from them the young escape at the end of nine days, and are fully developed at the end of eighteen. The lice are found in greatest abundance in the back and side portions of the head. "A single louse may lay fifty eggs within six days, which may be hatched in from three to eight days. The 'young ones' are capable of laying eggs themselves in another eighteen days or three weeks. A pregnant louse, therefore, may be the means of bringing forth some 5000 young ones in the course of eight weeks" (Professor Hebra). In women and children, because of their long hair, lice are more common than in men.

Fig. 149.—The Head-louse.

Very severe **symptoms** may be produced by the insects. Their biting irritates and wounds the skin. It also renders the skin itchy, and the person scratches. Between the two an inflammation of the skin is produced, an eczema (p. 318). The skin is torn with scratching, and blood escapes, which dries into crusts. An eruption of blisters of the size of a pin's head or a pea appears. These are torn and weeping, and the fluid dries up also into crusts. Beneath the crusts matter forms, and the hair becomes matted together and covered with nits. This condition of things, if not promptly attended to, spreads, and a foul, matted mass of scab and entangled hair is produced, among which the lice continue to breed. On the neck, but lessening from above downwards, scratches, pustules, &c., also are present, and the ears may be affected. The glands of the neck readily

become swollen, and often in children swollen and running glands in the neck are due entirely to the irritation of such a condition of affairs in the head (see p. 207).

Treatment.—Hebra advises the following treatment. A mixture of 3 ounces common petroleum, $1\frac{1}{2}$ ounces olive-oil, and $2\frac{1}{2}$ drachms balsam of Peru is made, and the hair treated with it down to the very roots every hour for a considerable number of hours. The head is covered with a flannel cap. After 24 or 48 hours, when the lice and their eggs will all be destroyed by the petroleum, the head is to be thoroughly washed with soap and water. The oil not only kills the animals, but also loosens the scabs, and the washing should remove them all. Matted hair is to be combed out by careful and patient combing, beginning at the ends of the hair. If an inflamed condition of head remains it should be treated as directed for eczema. The nits, though killed, are not removed by this method. To remove them bathe the hair with vinegar and water. This softens their sheaths. Afterwards they are removed by fine-toothed combs.

In milder cases, where no scabs have been formed and where all that is desired is the destruction of the lice, which are easily got at, it is sufficient to rub well into the hair some ointment of mercury, such as the blue ointment, or the red precipitate ointment.

The **body-louse** or clothes' louse resembles the head-louse, but is larger and more active. It is never met with on the head or hairy parts. It lives not on the skin, but in the folds of the clothing, whence it only sallies out to seek nourishment, obtained by piercing the surface layers of the skin and sucking.

Symptoms.—The irritation of the insect's bite produces a red spot, in the centre of which is a minute purplish speck, due to escape of blood. Severe itching is occasioned, and as the spot is slightly raised above the surface it is torn by the nails and bleeds. Scratches covered with blood-crusts are thus produced. Various other kinds of eruptions may be caused, blisters, pustules, scabs, &c. Where the itching and scratching have gone on for a long time, the constant redness of the skin excited thereby, leads to a darkening of the colour, most pronounced on the neck, wrist, and buttocks. In extreme cases boils and ulcers are produced. In spite of such signs, supplying unmistakable evidence of the presence of lice, if the person be stripped not a single animal may be found on his body, because they hide themselves in the folds of the clothing.

The **treatment** for body-louse consists in removing the garments in which the parasites lie hid. To kill them and their eggs they should be ironed with very hot irons, the folds and creases of the clothing being ironed over specially time after time. The sores on the body should be treated by simple dressings.

The **crab-louse** (Fig. 150) or pubic louse is flatter, broader, and shorter than the other forms. It lives chiefly in the hairy parts at the lower part of the abdomen—the pubic region, but may be found on the arm-pits, among the hairs of the breast, &c., but never on the head. It grasps the hairs firmly with its front feet, making its removal difficult. The nits are fixed on the hair quite close to the skin.

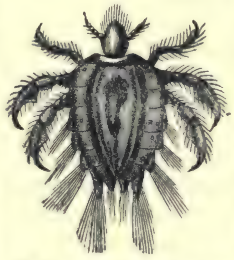


Fig. 150.—The Crab-louse, more highly magnified than Fig. 149.

Symptoms.—Itching is less severe than in the case of the head or body louse, but a pimply eruption may be induced.

Treatment is commonly by blue ointment of mercury. It is, however, apt to excite inflammation of the skin, and must, therefore, be cautiously used.

Eruptions produced by Fleas, Bugs, &c.

The **common flea** (*Pulex irritans*) produces rose spots with a purplish point in the centre. When the surrounding redness fades the central spot remains still dark, and cannot be made to disappear even momentarily by pressure of the finger. Within two or three days it passes through the changes of colour common to any bruise and then disappears. In sensitive skins a kind of nettle-rash may be produced.

Bugs (*Cimex lectularis*) hide in cracks of wood-work, bed furniture, &c. They are much larger than fleas or lice, and are of a rusty brown colour.

They cause intense itching and large wheals by their bites, and an eruption like nettle-rash may be brought out, which is well-marked in the morning, and fades in the course of the day, to be again well-marked next morning.

The **harvest-bug** (*Leptus autumnalis*) embeds itself in the skin, and produces a pimply eruption, accompanied by itching, which increases whenever the body grows warm, as after being in bed for some time at night.

Treatment.—The itching in any of these cases

may be allayed by a lotion of perchloride of mercury, 2 grains to the ounce of water. A stronger lotion of the same sort may be used to wash over cracks of wooden beds, &c., for the destruction of the insects. Great care must be exercised in its use, for it is very poisonous. The same end may be served by using a mixture of 3 parts unpurified petroleum to 100 parts of water. Fumigating a house with sulphur also destroys bugs.

Ringworm (*Tinea*) occurs in three varieties according as it attacks the scalp, the beard, or some other part of the body. In all cases it is due to the same cause, the presence of a vegetable parasite, consisting of minute round bodies, and of thread-like structures formed of rows of rod-shaped bodies of a beaded appearance. This is the growing fungus and its spores. To it the name **trichophyton** has been applied. Wherever ringworm occurs this is present between the layers of cells of the scarf-skin, in hairs and hair sheaths.

Ringworm of the body (*Tinea circinata*) is the name given to the disease when it occurs on the non-hairy parts of the body. It is most common on the face, neck, and trunk, and is found also on hands, arms, and wrists. It consists of small circular patches slightly raised and of a rose colour, and covered with small branny scales. Usually round the margin is a ring of very small blisters. The spot is the seat of a tingling and itching sensation. It spreads round the margins, and as it spreads heals in the centre, so that a large red ring with a pale centre is formed. When a large ring has been formed it often becomes irregular. The disease may end of itself. On the other hand it may spread and other rings may form on other parts because of the person scratching the diseased part, and carrying some of the fungus under finger-nails to some sound parts.

Ringworm of the scalp (*Tinea tonsurans*) begins by small red patches like the ringworm of the body and spreads at the margins (Plate IV.) It involves the hairs, which become penetrated by the fungus, and are dull, dry, and twisted. They are easily pulled out, and become very brittle, themselves breaking off near the skin and leaving projecting discoloured stumps. The affected patch becomes covered with a greyish white powder. Inflammation may be produced and crusts formed. The hairs, if pulled out and examined, are easily seen to be very much thickened. In advanced cases of the disease the hair follicles may be destroyed and a bald patch be left when the disease has disappeared. Several patches of the disease may exist and by spreading unite, forming one large irregular patch.

The disease of the scalp is commonest in children.

Ringworm of the beard (*Tinea sycosis*) has similar appearances—patches, red and circular, covered with fine scales, with stubbly, dirty-looking brittle hairs. The hair follicles become swollen and tender, and matter forms round them, becoming crusted. It may persist for months or years.

Treatment.—For ringworm of the body a lotion of bichloride of mercury (2 grains to the ounce of water) is often sufficient to kill the fungus. It can be frequently applied. If this is insufficient glacial acetic acid painted all round the spreading margins of the ring will usually succeed. It may be repeated if necessary. In ringworm of the head and beard the hair of the diseased patches, and for a little distance beyond, should be cut short; crusts should be removed by the application of poultices, by the use of plenty of oil, and by frequent washing with water and soft soap. The lotion of bichloride of mercury should then be applied. This treatment is much more certain of success if all diseased hairs are removed. This is done by catching them one after another by pincers and pulling them out, not one being left behind. If the patches are large, small bits may be cleared of hair at a time until, after several times, the whole patch has been cleared. The lotion should be well applied several times after all sign of the continued advance of the disease has disappeared. It may take months before the disease is finally got rid off. Meanwhile, if the person is not in vigorous health cod-liver oil, tonics, and good food should be administered, and strict cleanliness practised.

Honeycomb or **Crusted Ringworm** (*Tinea Favosa—Favus*) is figured in Plate IV. It is caused by a fungus resembling that of ordinary ringworm. To it the name **achorion Schonleinii** has been given. It attacks the scalp. Small itchy red patches appear first, then minute yellow specks, which gradually become larger till they attain some considerable size—some may even become as large as ½ inch in diameter. They form yellow crusts, depressed in the centre so as to be cup-shaped, through which a hair passes. There is itching of the parts; the hairs become dull, dry, and ash-grey, and they are brittle. In the end they may be destroyed and fall out. When the crusts are removed pits are

left in the skin, which, however, soon fill up. The crusts have a disagreeable mousy odour. The disease may last for years. It is contagious, and has been known to be transmitted from mice affected by it to the cat which caught them, and from the cat to children, whose pet it was.

Treatment.—It is necessary that the diseased hairs should be pulled out from the root. Forceps are required, and the difficulty in removing the hairs is due to their brittleness and tendency to break off short. It may take many weeks before the removal of hairs in this way can be stopped without risk of the disease recurring. During the removal of the hairs the perchloride of mercury lotion (2 grains to the ounce of water) should be rubbed into the part to destroy the fungus. Nourishing food and tonics should be given.

Pityriasis versicolor is a disease of the skin, occurring in patches of a peculiar brownish colour, and due to a vegetable parasite called the **microsporon furfur.** It begins in small spots about the size of a pin's head. They extend and unite, large irregular patches of the discoloration being produced. Itching is not great, and, on scratching, yellowish scales come from the patch. Children are seldom attacked. Persons who perspire freely and are not sufficiently cleanly, who do not use frequent bathing, may have it for years. It occurs chiefly on the chest and abdomen.

Treatment.—The affected parts should be scrubbed night and morning with soft soap and water, and, after drying, the skin should be well rubbed with the mercury lotion advised for ringworm.

Affections of the Glands of the Skin.

Excessive Secretion of the Sebaceous Glands (*Seborrhœa*). The sebaceous glands separate an oily fluid which keeps the skin moist and soft. This is produced in excessive quantity in the disease named. It occurs specially in young people between fifteen and twenty-five, on the cheeks, nose, and forehead. The skin has a greasy appearance, and minute drops of oil may be seen standing upon it. The face of a person affected seldom appears clean, because dust, &c., so readily adheres to the greasy surface. In old-standing cases the sebum forms flakes or crusts upon the skin of a pale yellow, brown, or greyish colour. When this occurs on the head the hair becomes matted together. This may be seen in children. The affection occurs also on the genital organs of both sexes.

In another form scales of dry secretion of a dirty white or pale yellow colour adhere to the surface of the skin, or the sebum assumes the appearance of branny scales, forming a fine mealy powder. This often forms on the scalp, and if allowed to accumulate forms scurf. In the disease the hair is affected and readily falls off, so that scurf and hair are continually falling from the head.

Treatment.—Thorough cleanliness is necessary. In the oily form on the face frequent washing with soap and water, and rubbing with towels, is the best treatment. Before the soap and water, oil may be rubbed over the parts to soften and bring away plugs of sebum in the mouths of the glands. If crusts have formed they should be softened and removed by rubbing with oil and then soap and water. An ointment of oxide of zinc may then be applied. Tonic treatment may also be needed.

Comedones (*Grub, Shilfcorn*) is the term applied to plugs of sebum that block the mouths of the hair follicles and glands. They appear as small dark points, and when pressure is applied by the finger-nails a little worm-like body with a black head is squeezed out. This is simply accumulated secretion, the exposed end being blackened by dirt. A parasite has also been found among the secretion—the **acarus folliculorum,** which, however, does not seem to give rise to any symptoms.

Comedones vary in size, and, if numerous, their black points are very unsightly. They are found most commonly on the face, back, and chest.

Treatment. — The accumulated material should be squeezed out by the finger-nails. Frequent washing with soap and water, followed by brisk rubbing, should be adopted to prevent their recurrence. Previous anointing with oil is an aid to the removal of the retained material.

Milia are small, white, round bodies lying beneath the scarf-skin, most commonly on the eyelids and cheeks. They are formed of sebaceous glands which have become filled with their secretion and unable to expel it.

Treatment.—A sharp needle readily slits up the cuticle covering the little body which slight pressure then turns out.

Wens are tumours formed like milia, but

much larger in size. They may attain the size of a nut or orange, and are common on the head and face. They are enormously distended sacs of the hair and hair-gland, containing accumulated sebum which may have undergone alteration.

The **treatment** is usually to dissect them out entire, or to open them out and clear out the contents. The operation, if the wen be on the scalp, is not unattended with risk. Erysipelas may arise; and great care is exercised by surgeons in operation. The rule is, indeed, that the wen is not disturbed, unless it is a source of annoyance.

Molluscum Contagiosum is a disease of the skin caused by blocking of the sebaceous glands. Tumours, similar to wens, are produced. They are filled with a milky fluid which is said to be capable of communicating the disease. They occur singly or in groups on the face, eyelids, chest, arms, and breasts of women. They are not painful. At the top of the tumour is a minute opening, through which frequently the contents of the sac may be squeezed.

Treatment.—The tumours are emptied by squeezing, after which the walls shrink so as to become flat, or they may be opened—of course only by a surgeon.

Excessive Secretion of the **Sweat Glands,** producing excess of perspiration, may occur over the whole body, as in exhausting diseases, and in weakened conditions of body after some illness, or it may be limited to parts—the arm-pit, hands, or feet. Parts thus affected often become very tender and painful, and a local eczema (p. 318) may be produced. In the case of the feet, the smell is very objectionable, and the term **stinking foot-sweat** has been applied.

Treatment.—The parts should be frequently washed with yellow soap and water. Into the part should be rubbed several times a day some of a solution made by dissolving 60 grains of tannic acid in 6 ounces of spirit. The skin should not be wiped after the application. Into the stockings of persons with sweaty feet some powdery material should be dusted—starch, lycopodium, or even common flour.

Sudamina (*Miliaria*) are small round blisters of the size of millet seeds, containing at first clear fluid, which, after twelve or twenty-four hours, becomes milky. The blisters appear like little pearls scattered about the skin. They last three or four days, then dry up, and thin scabs are thrown off. The fluid they contain is sweat, and they are produced by excessive sweating. A pricking sensation is experienced in the skin when the blisters are being developed. To this affection the term **prickly heat or summer rash** is applied by some. It attacks in hot climates; and the troublesome prickly sensation prevents sleep during the night.

Treatment.— *Warm baths should not be used.* The skin should be kept cool and dry, and the excessive sweating avoided if possible. Over the skin some fine powder, starch, &c., may be dusted to allay the irritation.

Acne (*Face Pimples—Stonepocks*) is a chronic inflammation of the hair sacs and of their attendant sebaceous glands. It appears as small red pimples chiefly on the face, chest, and back of young persons. They often arise after the mouths of the glands have been blocked by plugs of sebaceous matter—comedones, which the pimples surround. Sometimes the inflammation passes deeply into the skin, and the pimples extend inward, as little nodules. Often matter is formed which appears on the surface of the pimple. When the matter has been discharged the nodule may disappear, but a scar is left to mark its former place. An acne pustule may be so large as to resemble a boil. The affection usually declines after the twenty-fifth year of age or so. An eruption of acne pimples may be produced in some people by the taking of iodine as medicine, or by the application to the skin of some preparation of tar. Workmen who have to work with tar or some of its products are liable to exhibit such an effect.

Treatment.—Frequent rubbing with soap and water is recommended as one of the most efficacious means of treatment, because it softens the scarf-skin and removes some of its layers, and with them plugs blocking the sebaceous glands, the cause of the affection. When the back and chest are badly affected, hot baths greatly aid the treatment. A lotion of bichloride of mercury, one half-grain to 1 ounce of water, and glycerine, is also valuable. The treatment must be steadily persevered in for a considerable time; comedones (p. 327) should be removed by pressure, and matter should always be let out.

Acne Sycosis is a form of the affection attacking hairy parts, specially the beard. Through each of the pimples or pustules a hair is seen to pass. The pimples may come out in crops so close together, that patches of inflamed, thickened skin are formed, and separate pimples not noticed. The matter produced may, in such

cases, form crusts, pierced also by hairs. The hairs are loosened and fall out, and when the part heals depressed scars are left, on which hair does not again grow.

Treatment.—The hairs over the diseased part should be cut short. Warm poultices should be applied, and afterwards oil rubbed on to remove crusts. Thereafter the part should daily be gone over by a surgeon, and hairs from all affected parts pulled out with forceps. After each such procedure white zinc ointment, or chrisma sulphur, should be rubbed in. Hebra strongly advises daily shaving, not only to aid in curing the disease, but to prevent its return.

Acne Rosacea (*Gutta Rosea*) is an affection which appears on the face, specially the nose, forehead, cheeks, and chin, and is characterized by an intense reddening of the skin, without swelling. The redness is due to overfulness of the blood-vessels. They can be partially emptied by firm pressure with the finger, so that the redness disappears from the pressed part, but it returns on removal of the finger. The person experiences a sensation of warmth over the affected part, especially after a meal or in the evening. One form is confined to the nose, in which the lines of overfull vessels are readily seen, and the nose is shiny by increased fatty substance from the glands. But it may extend from the nose to the cheeks, forehead, and chin. The affected skin becomes thickened; and the nose is often considerably enlarged. Persons who indulge in alcohol to excess are liable to it. All kinds of stimulants, taken inwardly, increase the feeling of heat and the congestion of the part. When the disease has lasted for a long time nodules form on the skin, producing additional disfigurement.

The disease is most common in men after the fortieth year of life, and in women about the period of the change of life.

Treatment.—All irregularities of habits, &c., should be corrected if possible. The patient should live plainly and temperately, avoiding beer, wine, &c. Disorders of function ought to be attended to. The part should be well washed with soap and water, and then a sulphur ointment well rubbed into it at bed-time—the chrisma sulphur should be used, if obtainable. After several such applications, a few days should be allowed to elapse before repeating the process, since, at first, additional redness and removal of the skin is likely to result. Other methods might be adopted by a physician.

INJURIES TO THE SKIN.

Wounds, Burns, Chilblains, Frostbite, &c.

(See Accidents and Emergencies.)

AFFECTIONS OF THE HAIR AND NAILS.

Excess of Hair (*Hirsuties*).—Hair may grow in excess over large surfaces or over small areas, as a hairy mole, sometimes producing disfigurement. The hairs may be pulled out if they are few, or may be destroyed by various applications, called depilatories, if they are many. They should not be applied without advice, as they may give rise to troublesome ulceration.

Baldness (*Alopecia*).—Baldness results as one of the changes belonging to old age, due to wasting of the skin, hair sacs, &c. It may occur as a result of some acute disease, or at an unusually early age without any such cause. In both the latter cases it is undoubtedly due to defective nourishment of the hair, owing to lessened circulation of the blood in the scalp.

Treatment for preventing loss of hair, or for loss resulting from fever, consists in means that will quicken the circulation in the scalp, such as washing the head every morning in cold water, then drying with a rough towel by vigorous rubbing, and brushing with a hard brush till the scalp becomes red. A stimulating lotion should then be well rubbed in for several minutes. Wilson's lotion is made of sweet-almond oil, 1 ounce, strong liquor ammonia, 1 ounce, spirits of rosemary, 4 ounces; water, 2 ounces. At the same time generous diet, tonics, &c., may aid the restorative process.

One form of baldness, called **alopecia areata**, occurs suddenly in roundish patches. Probably the patches have existed for some time before they are noticed. They are smooth and white. Besides occurring on the head, they may be on eyebrows, cheeks, or other hairy parts. They tend to spread. When hair grows again on the patches it is fine, downy, and white, and it may remain white always, or at least for a long time. The loss of hair has been supposed by some to be due to a parasite. (See Plate IV.)

Treatment.—The spread of the disease can be arrested by painting the part with blistering fluid. This may be repeated every two or three weeks. Frequent brushing with hard brushes, the use of electricity applied by a wire brush, and various other methods, are also advised.

Greyness of hair (*Canities*) occurs usually

as a change of old age, but it may also occur in early life, and as a result of mental anxiety, shock, &c. The colour of hair is due to colouring matter developed from the papillæ from which the hair grows (p. 308). Any change of colour must begin at the papillæ, that is, at the end of the hair buried in the skin. As the hair grows the grey part advances, until hairs formerly coloured at length appear grey or white throughout their length. It takes, therefore, in all cases weeks, or at least days, before the change could be detected. There is no remedy for greyness of hair, except the use of dyes.

Inflammation of Nails (*Onychia*) may be produced by injury, pressure, &c., and sometimes occurs because of bad general health. Redness and swelling occur round the nail, and the bed of the nail is deep red. A feeling of heat and throbbing and pain on pressure are experienced. Matter forms; discharge oozes from the fold of the skin at the root; the nail becomes loose, and there is a raw tender surface beneath it. After the old nail has been shed, the new one grows slowly and the wound heals painfully.

" Ingrowing toe-nail" produces similar symptoms, limited to the part pressed on by the nail.

Treatment.—Warm poulticing will frequently give relief. The nail is also thereby softened and readily pared. In "ingrowing toe-tail" little bundles of some soft threads, torn from lint, of the length of the nail, should be laid on the nail in line with the inflamed fold, and should be gently pushed down, thread by thread, by means of some appropriate instrument, between the border of the nail and the inflamed fold. The fold is padded with fine strips of lint, and strips of sticking-plaster are wound round the toe from above downwards. By this means the nail and fold are separated. After wearing this for a day, a warm foot-bath is taken, the lint removed, and fresh strips applied. In a few days the swelling and pain will be so reduced that one may be able to remove with scissors the side of the nail.

The Care of the Skin, Hair, and Nails.—The chief aid to a healthy skin is cleanliness. The surface cells of the scarf-skin are continually being shed or rubbed off in minute masses, which are held together by the oily fluid exuding from the sebaceous and sweat glands (p. 308). This refuse matter is apt to collect on the surface, and, if it be not removed, to irritate the skin. Moreover the pores or channels of the glands are liable to become blocked, and the secretions to be thereby pent up. From both causes pimples, redness and blotching of the skin, especially sensitive skins, will readily result. Nor is the injury confined to the skin. It is an organ of purification, by whose means the blood ought to be cleansed from impurities. If cleanliness is not practised, this duty is improperly discharged, and the whole body may suffer in greater or less amount. Regularly some method ought to be adopted for removing the cast-off material, and the method is the bath—the use of soap and water, applied with moderately vigorous rubbing. The warm bath is undoubtedly the best for cleansing purposes, and the custom of taking a warm bath once or twice weekly is to be persevered in. But no one should come directly from a warm bath unless it is to get immediately into bed. Under any other circumstances the water ought gradually to be cooled down till it becomes luke-warm. The cold bath is useful not only for cleansing but for its bracing and stimulating properties. When one enters a cold bath, the stimulus of the cold to the skin excites the vasomotor nerves (p. 233) and the blood-vessels of the skin become much contracted, so that the blood is driven out of the surface into the deep parts. In a short time after coming out of the cold bath, the reaction should set in, the blood should rush from the deep parts to the surface, and a warm glowing sensation should be experienced. For a time the blood flows in greater quantity through the skin and then gradually there is a return to the usual condition of affairs. Now the effect on the nervous system and the quickened circulation that results have beneficial effects on the general state of the body. Cold bathing should not be persisted in, whether in ordinary baths or in the sea, if this reaction does not rapidly occur. If the skin remains cold and bluish, it is an indication against the cold or a warning that it has been too long persisted in. Rubbing, which should always be combined with bathing, is a great aid in hastening and ensuring reaction. Those who would like to take a daily cold bath, but are afraid of the consequences, should set themselves to work up to it, either by taking a warm bath, and gradually, day by day, diminishing the amount of warm water in it and increasing the cold, or by beginning with merely a rapid sponging on rising from bed, and gradually extending it till they are able to bear a regular cold bath. Friction with a wet towel or sheet may be em-

ployed to begin with.—A hot bath should range between 98° Fahr. and 112° Fahr., a merely warm bath not above 100°.

Soap should be used to the face as well as to other parts of the body, since nothing is so efficacious in removing the little plugs that block the mouths of the glands especially on the faces of young persons. But the soap should be thoroughly washed off, and the face bathed with cold water, before drying. Some persons, however, find soap absolutely irritating to the face. They may dispense with it, and instead add a few drops of spirits of ammonia to the quart of water with which to cleanse the face.

Cosmetics, especially those in the shape of pastes and powders that improve the complexion by covering up the offending spots, are often liable to do serious mischief by interfering with the natural functions of the skin. The wash of bitter almonds, recommended on p. 321 for freckles, may be employed with safety.

In regard to the hair too frequent washing should be avoided; and daily washing of the hair is too frequent, rendering it dry and brittle. Probably once a week is sufficient. For it, also, soap and water are the most suitable materials of cleansing. Salt of tartar, which is often put into the water, ought not to be employed. No comb or brush with sharp edges should be employed; and small-tooth combs ought not to be used. A comb should be used gently to disentangle the hair, and not to scrape the scalp, for the removal of dandruff is not aided by this means. Pomade should be employed with discretion, but only when the hair is of itself too dry. The best are those made of perfumed vaseline or chrisma, which do not become rancid.

Long hair is the better of being trimmed at the ends once every two or three weeks to prevent splitting. The practice of girls wearing short hair is one greatly to be encouraged. The crimping and plaiting and screwing up of hair requisite for those who wear it long is injurious, and is likely to lead to weakness and thinning especially at the parts where the greatest strain is exerted, very often the very front of the head.

Hair-dyes consist as a rule of a salt of lead or silver. Both are injurious, the former much more so than the latter, and all should be avoided. The idea conveyed in the term "Hair-Restorer," that a chemical preparation will restore to the hair the colour in which it is deficient without dyeing it, is a delusion, fostered by the vendor of the dye-stuff.

Nails should be cleansed with soap and water applied by means of a brush. A knife should not be employed to remove dirt from under the free edge, since it increases the space under the nail and affords more room for dirt to accumulate, while it scratches the nail, and foreign matter getting into the scratch will be removed with difficulty. The brush is, therefore, the best agent. Nails should not be so far cut, when being trimmed, as to prevent them affording protection to the finger tips. The soft prolongation from the surface of the skin on to the back of the nail at the root ought to be kept down by using an ivory presser, and not by means of a knife. If it is allowed to grow it becomes rugged and unsightly, and also painful by being torn and bleeding.

The hands require frequent washing. Those persons the skin of whose hands is dry and harsh, will derive benefit from rubbing with glycerine or vaseline. The use of the same substances will prevent and cure hacks in the skin, which if not attended to may become extremely painful.

The feet require as much, indeed more, attention than the hands. They also should be frequently washed with soap and water, and the nails trimmed. They should not be pinched up in narrow boots. The boots ought to have broad low heels, and ought to be broad enough in front to give the toes freedom. Those who are troubled with blistered feet after walking any considerable distance will find great benefit from rubbing some soft soap over the inner surface of the stocking in contact with the parts usually inflamed.

SECTION XII.—THE SENSES AND SENSE-ORGANS.

A.—THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Conditions of Sensation:
Terminal organs;
Fusion of Impressions.

Touch.

The Organ of Touch:
Pacinian Corpuscles and *Touch-bodies.*

The Sense of Touch:
The sense of contact—Aristotle's experiment;
The sense of pressure;
The sense of temperature.

Taste.

The Organ of Taste:
The Papillæ (filiform, fungiform, and circumvallate) of the tongue;
Taste-bodies—The nerves of taste.

The Sense of Taste:
Difference between taste and flavour.

Smell.

The Organ of Smell:
The Nostrils and their lining membrane (Schneiderian)—Nerves of Smell;

The Sense of Smell:
How excited—Its acuteness.

Sight.

The Organ of Sight (the Eye and its Appendages):
The Orbit;
The Eyelids—their glands (*meibomian*) and lining membrane (*conjunctiva*);
The tear-gland and passages—the explanation of weeping;
The Eyeball—Its sclerotic and choroid coats—Its chambers—The pupil of the eye—Its lens—Its nervous coat (*retina*).

The Sense of Sight:
The perception of light—the blind spot—the yellow spot;
The perception of objects—Comparison between the eyeball and a photographer's camera;
The accommodation of the eye to different distances;
Normal sight, short-sight, and long-sight;
The movements of the eyeball—The muscles of the eyeball—squinting;
The information gained by the eyes—Floating specks before the eyes—Purkinje's figures—Hallucinations—Estimate of size and distance by the eye;
Single Vision with two eyes—The stereoscope;

The Sense of Colour:
Fundamental and Complementary colours:
The perception of colour;
After-images.

Hearing.

The Nature of Sound:
Musical sounds—On what their loudness, pitch, and quality depend.

The Organ of Hearing (the Ear):
The outer ear—The auricle and external canal;
The middle ear—The drum of the ear—The Eustachian tube—The small bones of the middle ear;
The internal ear—The semicircular canals, and cochlea—Corti's organ.

The Sense of Hearing:
The perception of sound—Sympathetic vibration;
The range of the ear;
The sensation of discord;
Judgments formed by the ear.

The Conditions of Sensation.—The senses are the avenues by means of which information reaches the individual regarding the condition of his own body, and concerning the outward world which surrounds him, and of the manner in which it affects him. Every living being,

even the humblest, is not a mere separate existence, having a life of its own and independent of everything else; it is a part of a greater existence; and its value is estimated by the nature of the relations it bears to that great world of things of which it is but a mere speck. The most elementary living things have no nervous system, no special apparatus for communicating outwardly. They are little masses of irritable jelly-like living material (protoplasm), capable of acting as a whole, and with no part of their substance devoted to special purposes. An advance in this structure is perceived when a living thing shows evidence of having one part of its body devoted to the discharge of one duty and another part to the performance of another duty. The rudiments of a nervous system are found in some of the lowest animals, where one cell readily affected by certain agencies—contact with foreign material, for example—is situated near the surface of the body and communicates by a slender thread with a cell, capable of contracting, placed deeply in the body. Whenever the cell on the surface is affected sufficiently, the irritation of its substance that results is communicated along the thread to the deep cell, and excites it to contract, so that the body of the organism is moved. One cell is, as it were, on the look-out, and the business of the other one is to act on receiving information. Such a simple arrangement is sufficient for an elementary organism. But animals higher in the scale are affected in so many different ways by so many different agencies that a further subdivision of labour becomes necessary. One man may be a sufficient watch on the top of a small fort, but a large town needs a multitude of watchmen, each with his own particular duty and his own special post. So in the higher animals and man certain organs are set apart to give information regarding things the body comes in contact with, their hardness, their degree of heat, &c., all that is included under the sense of touch; another organ is set apart to give information about smell, another to inform regarding taste; another organ has as its business the duty of being on the look-out for light and colour, another for taking knowledge of sounds. The senses are thus the outposts of the mind, disposed along its walls to take note of and report to head-quarters anything that comes within the range of their duty. Without them man could have no knowledge of the outward world and could hold no relations with it. The information they supply acts, in great measure, as the motives and bases of his action. It is not out of place to remark how great, then, is the need of the information being accurate, and of the outposts being properly trained to their work, lest they mislead the mind!

There are thus a number of **special sensations**, touch, taste, smell, seeing, hearing, to which is added the muscular sense, by means of which information is supplied regarding outward things and forces. Besides these, however, there are a number of **common or general sensations**, the need of which arises from the highly complicated structure of the higher animals. The feature of such higher animals is the multitude of different organs in the body, each performing its own part of the general work required for maintaining the life and vigour of the animal. These organs must all work in harmony, and are in communication with one another. It is necessary that the individual should have some means of knowing whether the harmony is being maintained, and should have some warning if any organ is doing bad or indifferent work. Such information is supplied by common sensations. Thus a feeling of comfort informs of general well-being; a feeling of hunger or thirst informs of the need of certain substances to maintain nourishment; a sense of discomfort informs of some disturbance, and so on.

The essentials of a sense organ are well shown in the rudimentary forms of a nervous system, where there exists (1) one cell whose business it is to receive the impression, and (2) a nerve thread to carry the impression to (3) a cell whose business it is to receive the impression, and take knowledge of it in some way or other. These three elements are necessary for a sensation. (1) There is a special structure adapted for being affected by a particular kind of influence. Thus the eye is an organ specially formed for being stimulated by the action of light, while the ear is uninfluenced by light but is stimulated by the waves of sound, and so on. The special structures are called **terminal organs.** From the special structure, whatever it may be, (2) a nerve proceeds which is in direct communication with (3) nerve-cells in the brain in the region of consciousness. This last is important to notice. The nerve-centre to which the impression, made on the terminal organ, is conveyed by the nerve, must be situated in the brain, if the impression is to give rise to a sensation. Suppose the impression for some reason or other is arrested in the spinal cord, no sensation will result. Thus the nervous chain necessary for a sensation is not identical with that described on p. 86 as necessary for a

reflex action. A man who has had his spine injured, and is thus paralysed in both legs, does not feel a severe pinch of the skin of either leg, but probably the pinch causes the leg to be spasmodically jerked. An impression has been made on the skin, which has been transmitted to a nerve-centre. But the nerve-centre is in the cord. The injury to the spine has prevented the impression being conveyed up the cord to higher centres in the brain. Thus, though the impression has been quite sufficient so to stimulate a nerve-centre in the cord as to produce a marked reflex act, the man has been unaware of the pinch; he has had no sensation. A sensation, then, cannot be produced unless the influence has been transmitted to a higher centre in the brain, and has there excited a change of which the individual becomes aware. An impression may be duly made upon a terminal organ, but it cannot properly be called a sensation until the person becomes conscious of it. *A sensation may, therefore, be defined as the consciousness of an impression.* Now, if this is understood, it is easy to perceive that a sensation may be abolished in various ways. Take, as an example, the sense of sight. A person may be blind, as we all know, because of some injury or disease of the eye, because, that is, of something wrong with the terminal organ; but that is not the only way blindness may be produced. Another person might have perfect eyes, and yet have no sight. The nerve leading from the eye to the brain, the chain of communication, might be interfered with, destroyed, for example, by the pressure of a tumour, and, therefore, though light duly fell upon the eye and produced there its wonted effect, no knowledge of it would exist because of the rupture of communication—the impression could not be conveyed to the brain. In a third way a person might be prevented from seeing. Suppose the eye and its nerve unaffected, but the centre in the brain destroyed by the progress of some disease, the impression duly made on the terminal organ and carried along the nerve would reach a disorganized centre, which could not receive it, and no consciousness of sight would arise. But there are instances of failure to see, illustrating well the necessity for activity of the centre, not dependent upon any disease. Lift the eyelid of a sleeping man, and hold a lighted candle in front of the eye, an image of the candle flame is properly formed on the back of the eye, an impression is duly conveyed along the nerve to the centre, but the centre slumbers and there is no conscious sight. A man is walking through the streets engrossed in thinking over something; a friend walks straight towards him, and the person is apparently looking directly at his friend, but does not notice him and would pass on did his friend permit. His friend's face and figure made their usual impression on the eye, which was properly transmitted to the conscious centre, but that centre was already occupied, and the impression failed to arouse a consciousness of its presence. The same facts might be illustrated in connection with any other sense, but enough has probably been already said to show what are, in general, the conditions of any sensation. Sensation, then, is the result of a change occurring in a centre in the brain, and yet when the skin is pinched we refer the impression to the skin, though it is in the brain that it is actually perceived. We think it is our ears that recognize sounds; in reality it is only the brain that takes note of them as such. This habit of referring the sensation to the terminal organ which first received the impression is the result of education and habit. When we see a light, what we are conscious of is a change in a brain-centre, and yet we refer it outwardly. If the optic nerve be irritated by a current of electricity or by a blow, we see flashes of light as vivid as if lights actually danced before our eyes. Impressions have reached the centres for seeing, coming along the ordinary channels, and produce the same changes that lights should do. In this case, however, we know the cause of the colours, and correct the conclusion we would otherwise make. The seeing centre itself may be irregularly stimulated, by some condition of the blood, for example, and the person may see things which appear as real as if they were actual external existences, but which have only a temporary existence in his disturbed brain. Thus the man in *delirium tremens* sees fantastic figures dancing and making grotesque faces at him. His seeing centres, excited in an unhealthy way by alcohol, are of themselves producing changes which, in healthy circumstances, ought only to be aroused by real things external to him. The changes in the brain have, in this case, nothing corresponding to them outside, but the brain, nevertheless, refers them to the outside as usual, and they, therefore, appear to be real things. The man's judgment being otherwise also warped by the alcohol, he cannot correct his impressions, and is consequently victimized by them.

Fusion of impressions. It is a feature of all the senses that when they are excited by a series

of impressions, in which one follows the other very quickly, they are unable to distinguish the different impressions. The series becomes fused together, and the sensation is of a prolonged impression. Thus, if the finger be gently pressed on the edge of a toothed wheel, with the wheel going very slowly, the contact of each separate tooth is distinctly felt; but when the wheel is made to turn rapidly one loses the sensation of the separate teeth, and the feeling is of an uninterrupted kind. Again, every child knows that if a piece of string, which has been on fire at one end, be whirled rapidly in the air, the appearance of a wheel of fire is produced. The one point of fire becomes a circle. This sensation is produced by a rapid series of impressions. From every point of the circle, described by the glowing end of the string, from point after point of it in quick succession, an impression reaches the eye of the glowing point as it travels round. But all the different impressions follow so hard after one another that they are not separately distinguished in the mind, which thus becomes conscious of a continuous circle of light (p. 343). It is the same with sound. If an instrument be made slowly to emit a series of sounds, each sound of the series may be recognized separately; but if they be produced with a certain rate of rapidity, one sound is heard before the one preceding has died out, and a continuous instead of an interrupted sound is heard.

Now the explanation of this fusion of impressions is the same for all the senses. It is that the sensation lasts longer than the stimulus producing it. A flash of light in the darkness may last for a very small fraction of a second, but the effect on the eye does not vanish with the flash. It continues for a very brief space of time longer, and if a second flash be produced it may again excite the eye before the first impression has faded, and so the two become blended. Most people have noticed that if a shrill sound, say a railway whistle, has been prolonged for some time, they are doubtful of the exact moment when it ceased. The sound appears to ring in their ears some seconds after it actually stopped. If it had begun again before the ringing had left their ears, probably many would not observe that it had stopped for an instant. It would seem to have only become feebler for the moment.

TOUCH.

The Organ of Touch.

The organ of touch is situated in the skin throughout its whole extent, and in the mucous membrane of the mouth and nostrils. On p. 307 the structure of the skin is described, and the two layers of which it consists are noted. It is only in the deep layer that blood-vessels and nerves are found. The nerves terminate in many cases in a peculiar way. In many of the papillæ or ridges into which the true skin is thrown (Fig. 144, p. 307) are oval-shaped bodies about the 1-300th of an inch long, formed apparently of layers of fibrous tissue. A nerve-fibre winds round this body and finally enters it. These are called **touch-bodies** or **tactile corpuscles**, and are found in the skin of fingers and toes. In the tissue under the skin of the hand and foot of man are other bodies, called **Pacinian corpuscles**, larger than touch-bodies, the largest being 1-20th of an inch long. Each one is placed on the end of a nerve-fibre, which is like a stalk to it, the fibre passing directly into the centre of the corpuscle. Besides these two special forms of nerve-endings in the skin, there are the simple terminations of the nerve-fibres in the form of a net-work in the upper part of the true skin. In all cases the nerve-endings never reach the surface. Any impression must be communicated to them through the cellular layers of the scarf-skin.

The Sense of Touch.

The sense of touch is aroused by stimulation of the nerve terminations, already described, either by mechanical means or by heat or cold. When we lay our hand on anything, the mere mechanical contact with the body produces a sensation of touch, and if the body be warmer or colder than the hand a sense of heat or cold is aroused. Touch includes three things: (1) the sense of contact, (2) the sense of pressure, (3) the sense of heat and cold.

(1) The **sense of contact** is the most important element in touch. By it we gain information as to the form, size, and other characters, smoothness, hardness, &c., of external bodies. The sensitiveness of touch varies in different parts of the skin. Where the scarf-skin (epidermis) is thinnest it is most acute; where it is thickest it is more dull. The absence of epidermis altogether does not render the part more sensitive to sensations of contact. The direct contact with the unprotected true skin occasions pain, which effectually masks the feeling of contact. The tips of the fingers, the red border of the lips, and the tip of the tongue are the most sensitive parts. Experiments have been made on the degree of sensibility of various parts to

touch, by using a pair of compasses with points blunted by pointed pieces of cork, and determining how much the compasses required to be open for the impression of each point to be felt. If the two points were very near, the sensation was of one point only, and in order to produce the sensation of two points the ends of the compasses had to be separated by varying distances according to the part of the skin experimented on. The result showed that two points could be distinguished by the tip of the tongue though they were only 1-24th of an inch apart, by the tip of the forefinger if 1-12th of an inch apart, by the red surface of the under-lip if 1-6th of an inch apart, by the tip of the nose when 1-4th inch apart, by the palm of the hand if 5-12ths inch apart; and that the points of the compasses required to be separated 1⅛ inch to be perceived as two, when placed on the back of the hand, while in the middle of the thigh they required to be separated 2½ inches.

(2) The **sense of pressure** is different from the sense of contact, for sometimes those parts which are less acute for mere sensations of touch are more correct in gauging pressures. It is by the sense of pressure that we estimate differences of weights. Another element is introduced, however, in judging of weight, when the weight is taken in the hand, and the hand moved up and down. The weight offers resistance which the muscles require to overcome, and this calls forth what has been called a **muscle sense**, a sensation produced by the muscles, caused by the resistance offered to their movement.

(3) The **sense of temperature**.—The skin also judges of heat and cold, but its judgments are in this case liable to serious error. If one hand be very cold and the other very warm, and both be placed in the same basin of tepid water, the warmth of the water will be very different to each hand. To the warm hand it will appear cold, and to the cold hand warm. We cannot, therefore, judge absolutely of temperature. Then again the thickness of the scarf-skin seems to affect the sensitiveness to heat, for parts with thin epidermis can bear less heat than parts with thick epidermis.

Pain is an excessive stimulation of the sensory nerves, and in it all finer sensations are lost. Pain at once takes the place of other sensations, whether of contact or of pressure or of temperature, at that part of the skin so deprived of the epidermis as to lay bare the true skin.

The sense of touch supplies information according to the degree of its education. A common instance of this is the use of the blind alphabet—in reading by the fingers. An untrained person cannot distinguish the form of the raised letters; all is to him confused and indistinguishable. We all know how persons who have been born, or have early become, blind train their sense of touch to supply them with much of the information they would otherwise gain by sight.

A curious illusion of contact is shown in an experiment of Aristotle's. Place a marble between two fingers, so that it touches one side of one finger and the other side of the other finger. There is the sensation of one marble. Now cross the one finger over the other so that the marble is supported by the other sides of the two fingers, the sides not opposed to one another, and roll the marble between the two fingers, the impression of two marbles will be received, more particularly if the eyes are shut. Probably this is the result of habit, for the two surfaces of the fingers could never make contact with one object, unless the fingers were crossed in this unnatural way. Usually an impression on each surface at the same time would arise from two different bodies, and as this has always been the case the habitual impression is aroused even when, by crossing the fingers, one body is made to touch both surfaces at the same time.

TASTE.

The Organ of Taste.

The Tongue and Soft Palate are the seat of the organ of taste, which consists, like that of touch, in a particular mode of nerve termination. The tongue is composed mainly of muscular fibres running in various directions, and freely supplied by nerves and vessels. It is covered by mucous membrane similar to that lining the mouth, which contains glands in the deeper layers. The surface of the mucous membrane is thrown into irregular projections, called **papillæ**, of various forms. The **filiform papillæ** are very short, fine, hair-like processes, which are exceedingly numerous over the whole surface. The **fungiform papillæ** are broader and mushroom-shaped, and are scattered over the surface. They often project as red points when the rest of the tongue is white and furred. The **circumvallate papillæ** are the largest of all, and the least numerous. They are so called because consisting of a fungiform papilla surrounded by a fold of the mucous membrane. They present the appearance of being walled round. They are found near the back of the

tongue, being ranged in two lines, passing from a point in the centre of the surface towards the sides. There are only about a dozen of them altogether. The papillæ all contain twigs of vessels and branches of nerves, and are covered by epithelial cells. In the circumvallate papillæ are peculiar structures called taste buds. Fig. 151 shows a section of such a papilla, in which A is the centre, and B B sections of the surrounding fold. A trench is seen to separate the centre from the surrounding fold, and at the sides of the central papillæ, in the deep parts of the trench, are a number of flask-shaped bodies (T T). These are the taste buds. They are barrel-shaped, and are formed of stave-like epithelial cells, represented in II of the figure. In the inside of the buds are finer cells, represented at III. The mouths of the buds open into the trench. The taste bodies are connected with nerve-fibres, and it is supposed they are peculiar adaptations of epithelium, readily excited by sapid substances and transmitting the impression along the connected nerve.

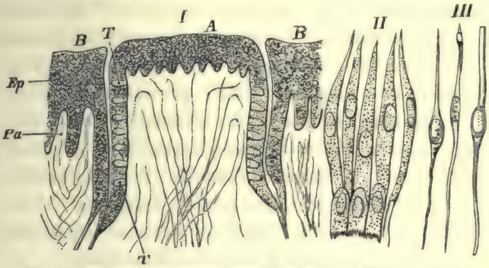


Fig. 151.—Section of Circumvallate Papillæ of the Tongue—highly magnified.

I A, Section of the central papilla. B B, Section of the surrounding elevation. Pa, Papilla of the true skin. Ep, Layer of cells—epithelium. T, Taste buds. II and III represent very highly magnified views of cells of the taste buds.

The tongue is supplied with sensory fibres by two nerves, the glosso-pharyngeal, a branch of the eighth cranial nerve (p. 96), and a branch of the fifth cranial nerve (p. 95)—the gustatory branch. The former confers taste on the back part, and the latter on the front part of the tongue. Branches of the former also pass to the soft palate and neighbouring parts, and confer taste on it.

The Sense of Taste.

The **sense of taste** is excited by stimulation of the mucous membrane of the tongue and palate affecting the terminations of the nerve-fibres and causing impressions to be transmitted to the brain. The stimulation seems to be a chemical one; and the substances must be in solution to produce taste. A dry condition of the mouth is not favourable to taste, and powders are not tasted till dissolved by the juices of the mouth. Various kinds of substances are capable of producing the stimulus, acid substances, alkaline and saline substances do so. Acid tastes are perceived by the fore part of the tongue, bitters by the back part and not by the fore part. Sweet and salt tastes are perceived by both. Stimulation of the nerves, for example by electricity, and without the presence of any tasty body, will excite sensations of taste. The nerve-centre for taste receives an impression transmitted by the nerve, and has no means of distinguishing between such impressions and others excited in a regular way. Similarly morbid conditions of the body may excite sensations of taste.

The taste of many substances is got rid of with difficulty. This may be due to the extreme sensibility of the nerve terminations to some substances. Thus 1 part of sulphuric acid in 1000 parts of water will be detected by the taste, and it may be that the taste remaining in the mouth is due to traces of the substance. Like other senses, that of taste may become fatigued. Repeated tasting of one substance rapidly deadens the sensibility, probably because of over-stimulation.

The sense of **flavour** is something more than taste. Flavour is a conjunction of both smell and taste. Thus, if the eyes of a person be blindfolded, and the nostrils firmly held, the person will be unable to distinguish between an apple and an onion, if one be rubbed on the tongue after the other. As soon as the nostrils are open the difference is perceived. In a similar way a common cold, causing blocking of the nose, interferes with the sense of flavour, as it abolishes smell.

SMELL.

The Organ of Smell.

The nostrils contain in their mucous membrane the structures devoted to the sense of smell. Reference to Fig. 9, p. 19, shows the cavity of the nostrils so far as formed by bone. The roof of the cavity is formed by the ethmoid bone, the upper surface of which forms part of the floor of the brain cavity, so that this horizontal plate above separates brain cavity from the cavity of the nostrils. Part of the side walls of the nostrils, as low as the floor of the cavities for the eye (see p. 19), are formed by light scroll-like prolongations of the same ethmoid bone, the remainder of the side walls being

formed of part of the upper jaw-bone. A central perpendicular plate of the ethmoid divides the upper part of the cavity into a right and left portion, and this division is continued downwards by the ploughshare bone (p. 19), and completed by gristle. The bony palate forms the floor of the nostrils. There is an opening to each nostril behind, into the back part of the throat, as well as in front. The walls of the cavities are lined by mucous membrane, richly supplied by vessels and nerves. The nervous

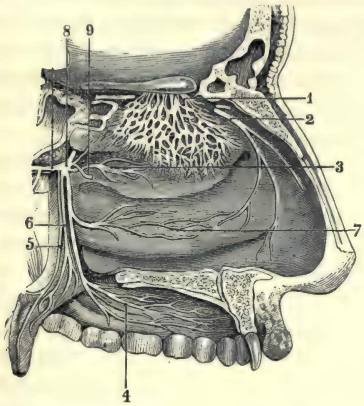


Fig. 152.—Distribution of Nerves over interior of Nostrils, outer wall.

1, Branches of nerves of smell—olfactory nerve. 2, Nerves of common sensation to the nostril. 4, 5, 6, Nerves to the palate springing from a ganglion at 3. 7, 8, 9, Branches from one of the palate nerves to nostrils.

distribution is shown in Fig. 152, where branches of the fifth cranial nerve are seen traversing the cavity and passing over its walls. The nerves of smell proper are, however, shown spreading in a thick brush over the upper and middle scroll-like bones of the outer wall, and over the upper part of the inner wall. They are found in the mucous membrane. These nerve-fibres are derived from the first pair of cranial nerves—the olfactory (p. 95), which rest on the upper surface of the ethmoid bone, and send branches through openings in its horizontal plate, which, because of the many perforations in it, is called the **cribriform** plate. The terminations of these nerve-fibres seem to be connected with epithelial cells lining the surface of the mucous membrane. The membrane is called the **Schneiderian membrane.**

The Sense of Smell.

The sense of smell is excited by the contact of particles contained in the air with the terminations of the fibres of the nerve of smell. But these, as we have seen, exist in the upper parts of the nasal cavities. In ordinary quiet breathing the air passes through the lower part of the nasal cavity, and the air in the upper regions is barely disturbed. If few of the odour-bearing particles are in the air, they may never reach the true olfactory region, and no smell will be felt. In such a case if a sudden sniff is made the air is forcibly drawn into the nostrils, passes up even into the upper chamber, and thus a faint smell becomes readily perceived.

The sense of smell is extremely acute. According to Valentin $\frac{3}{100,000,000}$ of a grain of musk can be distinctly smelt. Like taste the sense of smell becomes readily fatigued. Thus, after remaining a time in an atmosphere whose smell appears strong when we first enter it, we gradually fail to perceive the odour, and it is only when we have passed out again to the fresh air that we again perceive the difference. Smell is related to taste in the perception of flavours, as already noted under TASTE. The swelling of the lining membrane of the nostrils caused by a cold abolishes smell, probably both by preventing the entrance of air to the upper parts of the chambers, and by burying and obscuring for a time the terminations of the nervous filaments.

Sensations of smell may be excited by stimulation of the centres for smelling in the brain, owing to some abnormal condition and not due to impressions produced on the terminal organ by any odoriferous particles.

SIGHT.

The Organ of Vision—The Eye and its Appendages.

The Orbit.—The eyeball is situated in a bony cavity called the orbit, formed by various bones of the head and face (see p. 19). The cavity is padded by a loose fatty tissue, the diminution in the amount of which aids in producing a sunken appearance of the eyes.

The Eyelids are formed of folds of skin, the outer surface having the structure of ordinary skin, the inner of mucous membrane. In the body of the lids is a layer of condensed fibrous material which maintains the shape of the lids. Nearer the inner than the outer surface of the lids is a row of glands, which open on the free edge of the lid and pass from there into the eyelid in a vertical direction. These are the **Meibomian glands.** The blocking of one of these glands by the material it itself produces leads to the formation of a sty. Towards the front of the free edge of the lids are the eye-

lashes, which are thick and capable of rapid growth, so that if one falls or is pulled out another quickly grows in its place. The inner lining membrane of the lids is very richly supplied with vessels and nerves. The membrane is called the **conjunctiva.** It is continuous with the skin at the free edge. After lining the inner surface of the lid it passes over on to the eyeball. In ordinary inflammation from cold it is this membrane, whose blood-vessels are engorged with blood, that is the seat of the redness and swelling, and it is because it continues forwards over the eyeball that the eye has its bloodshot appearance in such cases. Such inflammation is called **conjunctivitis.**

In the eyelids are muscular fibres which close the lids by their contraction.

The tear-gland (lachrymal gland) and passages. Situated outside of the eyeball among the loose fatty tissue of the orbit in its upper and outer corner is the lachrymal gland. From it several little channels lead which open on the inner surface of the upper lid. The fluid produced in the gland passes out by these openings and flows over the eyeball. It is ordinarily just in sufficient quantity to keep the eyeball and lids moist, to wash off dust, &c. Having flowed over the eyeball the fluid collects at the inner angle of the lids. At this place in each lid is a little projecting point (**punctum lachrymalium**) in the centre of which is an opening. The openings communicate each with a small canal in the lid, which passes to the angle between the orbit and bridge of the nose, where is lodged a little sac—the **lachrymal sac.** The canal of both upper and lower lids joins this sac, and from it there passes a channel—the **nasal duct,** lodged in a canal in the bone, which leads into the lower part of the nostril. The fluid which has flowed over the eye is carried off by the canals and drained into the nose. The lining membrane of the eyelids is continuous through these canals with that of the nostrils, and thus redness and swelling of the nasal membrane, caused by cold, are apt to pass upwards and inflame the eyelids. The canals are often blocked by inflammation, and the fluid collects in the corners of the eyelids and flows over on to the cheeks.

The secretion of the lachrymal gland is under the control of the nervous system. Anything that irritates the eyelid leads to stimulation of sensory nerves, the impression passes to a nerve-centre in the base of the brain, from which nervous impulses travel to the gland leading to increased flow of its secretion. The first act in the process may be the excitement of sensory nerves in the nostril, as by the smelling of pungent salts. The stimulation of the same nerve-centre results, with its consequences of increased flow. A mental emotion, joy or grief, may stimulate the centre and produce similar results. In such cases the fluid is produced in such quantity that it cannot escape by the lachrymal canals quickly enough, and the excess rolls over the cheeks as tears. This is the explanation of weeping. Some people are "dry-eyed" in times of deep grief or other emotion. The explanation of this is as simple. The nervous influence acts on the centre in a precisely opposite way, so that instead of it stimulating the flow of blood through the gland and otherwise exciting increased activity, the nervous impression arrests the activity, so that less fluid than usual is produced. In a similar way the emotion which produces blushing in one man leads to pallor in another. In the former case the nature of the nervous effect is to permit a greatly increased flow of blood through the vessels of the face, and therefore redness of the surface, in the latter case it diminishes the natural flow, therefore there is less blood in the part and consequently less colour.

The Eyeball is a globular chamber. Its walls consist of several layers. The outermost layer is called the **sclerotic,** is a tough fibrous coat formed for protection and maintaining the shape of the ball, and is thicker behind than in front. This coat is white in appearance, and is the part easily visible to which the phrase "white of the eye" is applied. In the very front of the globe the sclerotic is abruptly transformed into a transparent portion which is circular and which forms a window through which one can see into the interior. This is the **cornea.** The sclerotic is supplied with vessels and nerves, but the cornea, though containing nerves, has no blood-vessels. It is composed of layers of fibres with numerous minute spaces between them, in which little masses of protoplasm lie. The masses send off numerous processes which communicate with one another, so that the substance of the cornea is traversed by fine threads of protoplasm connected with masses. No doubt by this living material, in lieu of vessels, the nourishment of the cornea is maintained without its transparency being interfered with. The visible part of the white of the eye is covered, as already noted, by the delicate membrane, the conjunctiva, reflected

from the inner surface of the lids. This membrane has the structure of mucous membrane, fibrous tissue covered by layers of epithelial cells. But when the conjunctiva reaches the cornea, only its epithelial layers are continued over the cornea. In inflammation of the cornea blood-vessels rapidly shoot into its substance from the conjunctiva around.

Lining the inner surface of the sclerotic is the second coat of the eyeball—the **choroid.** This is essentially the blood-vessel coat of the eyeball.

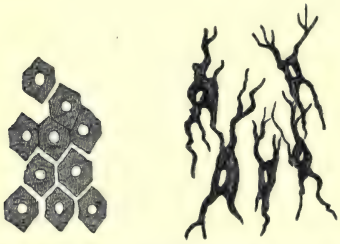


Fig. 153.—Different Kinds of Pigment Cells from Choroid Coat of the Eye.

It contains a multitude of small arteries and veins whose connecting capillaries form a very close net-work. Connective tissue surrounds the vessels, and in the tissue are branched cells so loaded with colouring matter as to be quite black. Their appearance is shown in Fig. 153. The front part of the choroid terminates about the place where the sclerotic passes into the cornea in a series of ridges, the **ciliary processes.** The circular space thus left in front by the termination of the choroid is occupied by the **iris,** a round curtain, the structure seen through the cornea, differently coloured in different individuals. In its centre is a round hole, the **pupil,** which appears as if it were a black spot. The margin of the iris is connected firmly with the eyeball all round, at the line of junction of the sclerotic and cornea.

The **iris** forms a sort of transverse partition dividing the cavity of the eyeball into two chambers, a small **anterior chamber,** extending from the front part of the iris to the back part of the cornea, filled with the **aqueous humour,** a fluid consisting almost entirely of water with a very small quantity of saline material in solution, and a large **posterior chamber,** filled with **vitreous humour,** a kind of fine transparent, colourless jelly. The iris consists of a framework of connective tissue, and its posterior surface is lined by cells containing pigment which gives the colour to the eye. In its substance are bundles of involuntary muscular fibres, one set being arranged in a ring round the margin of the pupil, the other set radiating from the pupil like the spokes of a wheel. When the circular fibres contract the pupil is made smaller, but if these fibres relax the radiating fibres cause the pupil to dilate more or less widely. The object of this will be seen hereafter.

Just behind the pupil is the **crystalline lens,** resembling a small, very strongly magnifying glass, convex on each side, though more so behind. It is perfectly transparent in the healthy state. The front face of the lens is quite close up to the curtain of the eye, and the vitreous humour, occupying the posterior chamber, is closely in contact with its back face. But the lens is not loosely placed in the eyeball; it is inclosed in a capsule, the **suspensory ligament,** which not only retains it in position, but is capable of altering its shape. For the lens is elastic, its capsule is connected with the ciliary processes, and is kept usually tense, so that the lens is flattened somewhat by the pressure exerted on it. But all round the edge where the cornea, sclerotic, and choroid meet is a ring of involuntary muscular fibres, forming the **ciliary muscle.** When this muscle contracts it pulls forwards the attachment of the suspensory ligament of the lens, whose pressure on the lens is consequently diminished, and the elasticity of the lens causes it at once to bulge forwards, becoming thereby more convex. The

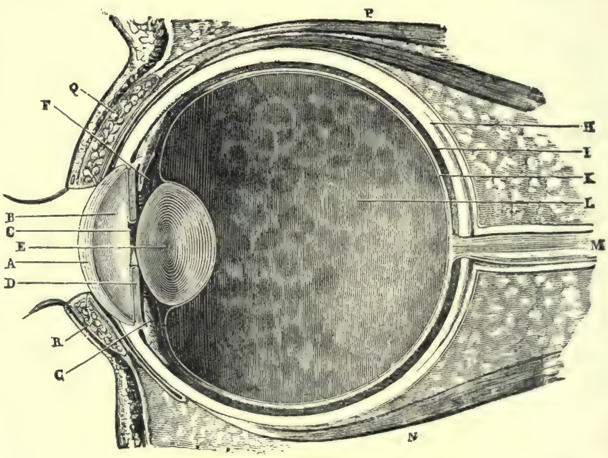


Fig. 154.—Representation of a vertical cut through the Eyeball in its Socket. For description see text.

value of this movement will be understood immediately.

Reference to Fig. 154 will render the position of the parts already described more intelligible. It represents the eye lying in its socket, partly covered by the eyelids, and completely opened up by a cut from front to back. In the figure muscles (P, N) of the eyeball are shown, and a meibomian gland opened up (Q, R) is represented in each lid. A is the cornea which, at the place across which the lines from F and G pass, joins the white sclerotic (H). The cornea closes the front of the anterior chamber (B), which is filled with aqueous humour, and the back wall of which is formed by the curtain of the iris (D). In the middle of the back wall is the opening of the pupil (C), through which is seen the lens (E). F and G point to the region of the ciliary muscle and ciliary processes, the forward termination of the choroid coat (F). Behind the lens is the posterior chamber (L), filled with vitreous humour.

Our description is not yet complete, however. The eyeball, at least the posterior chamber, has an innermost lining, called the **retina** (K). The **retina** lines nearly the whole of the inner surface of the posterior chamber, lying on the choroid coat. It is, consequently, with the retina that the vitreous humour is in contact. The retina is the nervous coat of the eye; it really forms the terminal organ (p. 333) of the sense of sight. It is a very thin, soft, white membrane. If the fresh eye of a sheep or ox be opened, and the jelly-like vitreous humour removed, the retina will be seen and easily separated as a pulpy membrane from the dark coloured choroid on which it rests. But it does not separate completely. At one spot it is bound down. This spot is the entrance of the **optic nerve.** The nerve (M) comes from the brain (p. 95) and pierces the eyeball at the back, not quite at the middle, but about $\frac{1}{10}$th of an inch to the inner side, the nose side. The fibres of the nerve are distributed in the retina. The retina does not extend quite to the front limits of the posterior chamber, but stops short, in a scalloped border, the **ora serrata,** a little way behind the ciliary processes.

Though the retina is extremely delicate, its structure is very complicated. If a piece of the retina, representing its whole thickness, is examined under a microscope it shows a structure exhibited in detail in Fig. 155. The part resting on the choroid coat consists of six-sided granular nucleated cells filled with colouring matter (Fig. 153). Outside of that is a layer called **Jacob's membrane,** containing bodies termed **rods and cones.** To this succeeds a layer of nuclear bodies developed in fibres continued

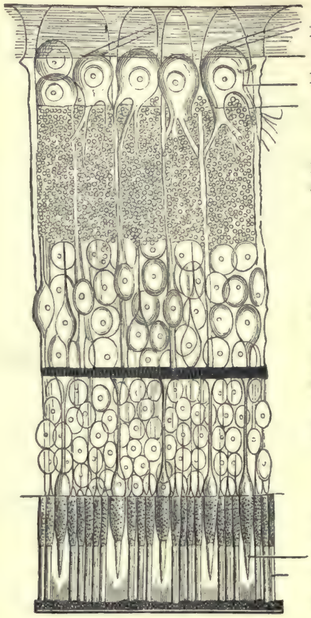


Fig. 155.—The Microscopic Structure of the Retina.

from the rods and cones. Outside of these a granular layer, and other nuclear bodies, &c., as represented in Fig. 155. The two layers nearest the surface of the retina, nearest the vitreous humour, therefore, are a layer of nerve-cells and nerve-fibres. In the retina vessels ramify in the region between the inner granular layer and the surface next the vitreous. The vessels are branches of the artery that enters in the substance of the optic nerve.

At the entrance of the optic nerve the retina contains no rods or cones. In the retina at a point exactly in the middle of the back wall, therefore directly opposite the centre of the pupil, (about $\frac{1}{10}$th of an inch to the outer side of the optic nerve entrance), there is a yellowish spot of an oval shape, the **macula lutea,** or **yellow spot** of Soemmering, which exhibits a central depression. At this part the retina is very thin, all the layers being very much diminished in thickness, except that of the rods and cones, the layer of nerve-fibres being absent. In the layer of rods and cones marked differences from other parts also exist, for rods are scarce and cones are very close and numerous.

The rods and cones are to be regarded as the peculiar modes of termination of the nervous filaments in the eye, just as the taste buds are

the modes of termination of the nerve of taste in the tongue (p. 337), just as the touch-bodies are the terminations of the nerves in the skin (p. 335), and just as epithelial cells of a peculiar shape form the terminations of the nerves of smell in the nostrils.

THE SENSE OF SIGHT.

The Perception of Light.—The agent that excites the terminations of the nerve-fibres in the retina is light. The sensation of light is produced in the brain by impulses reaching certain nerve-centres and coming along the optic nerves. These impulses are, in ordinary circumstances, sent along the optic nerves by the retina, and are communicated to the retina by the vibrations of ether which are held to be the physical cause of light. But any excitement of the optic nerve, if it be passed on to the brain, will produce a sensation of light. Thus electrical stimulation of the optic nerve will do so, because it, equally with the usual stimulus of light, sets up changes in the brain cells, which occasion the sensation. Mechanical stimulation, of which the commonest form is "a blow on the eye," will also excite the nerve and produce sensations of light. It is the terminations of the nerve-fibres —the rods and cones, not the fibres of the nerve themselves, that are excited by light, for light falling directly on the optic nerve alone has no effect, while the feeblest glimmer of light will excite the retina and lead to a luminous impression.

The whole surface of the back of the eye is not, however, equally sensitive. There is, indeed, a spot, where the optic nerve enters the globe, completely insensitive to light. It is, therefore, called the "**blind spot.**" Light falling upon it produces no stimulus. At this point there are no rods and cones, and in this fact is one reason for the belief that the rods and cones are the agents by whose aid the waves of light become transformed into the stimulus of a sensation. A simple experiment proves this. Shut the left eye, and hold the thumbs of each hand side by side directly in front of the eye, with a good light falling upon them, and at the distance one would hold a newspaper in reading. Fix the right eye on the nail of the *left* thumb, and then move the *right* slowly away to the side. Though the eye is steadily regarding the left thumb both are seen, when the right is moved only an inch or so, but when the right thumb has been moved off several inches, the end joint disappears from view, though the shut hand is still visible, and when it has been moved a little further the whole right thumb is again visible to the eye, still fixed on the left thumb. The explanation is that at a particular distance the rays of light from the end of the thumb fall on the blind spot, and give rise to no sensation, and when the hand is moved to one side or other of this place the rays fall on the retina on one side or other of the optic nerve entrance and so produce the sensation. If when the thumb has disappeared the hand be moved in any direction, forwards or backwards, the thumb will again come into view, for the rays will be made to fall on the retina. The same thing may be shown in another way. Shut the left eye and fix the right on the small letter a (Fig. 156).

Fig. 156.—To show the "blind spot."

Then move the book near to or farther from the eye. In one position the large letter A disappears from view, in others both are visible.

The yellow spot (p. 341), directly in the centre of the back of the eye, is the most sensitive part of the retina to light. Objects are most distinctly seen when the eyes are so directed towards them that light from them falls on the yellow spot. In this spot cones are specially numerous, there are no fibres of the optic nerve, and the other layers of the retina are very thin. This is another reason for the belief that the rods and cones are the true essentials of the terminal organ of vision. In looking at any extended object the eyes are rapidly moved in various directions, so that its various parts are brought in line with the yellow spot. As a result of a fusion of all the different impressions received, which fusion is effected in the brain, the person judges of the appearance of the object as a whole. This grouping of impressions we are often unconscious of. It is done so rapidly and so habitually that we are apt to believe that we see with equal distinctness the whole of an extended object at once. In reading a printed page we know the eye moves so as to perceive one word after another in the printed line, and if we fix the eye on the centre of the line the ends will be indistinct. It is because we move the eyes so rapidly, and because we learn to take notice only of the distinct impressions, due to rays of light falling

on the yellow spot, that we are quite unconscious of the existence of a blind spot.

The stimulation of the retina does not pass off immediately the cause ceases to operate. Its effect lasts for a distinct period, about the $\frac{1}{8}$th of a second. If, therefore, two impressions follow one another at a less interval they appear as continuous, since the effect of the one has not passed off before the other is produced. If, in a series of flashes, one follows another at less than the interval named, the impression of a continuous flash will be produced. It is thus that a string, glowing red-hot at one end, and rapidly whirled round, produces the impression of a circle of light. This fact is taken advantage of in the construction of the wheel of life. Here a set of pictures is produced on a circular band of paper, which is set in a revolving wheel. The pictures represent a man, let us say, in the different positions he would be in, one instant after another, during the act of walking, for example. One picture follows another in its proper order, and when the wheel is rapidly revolved the appearance of the man walking is produced.

The Perception of Objects.—Were the retina the complete terminal apparatus of vision all that one could be conscious of would be a sensation of light whenever the retina was stimulated, but we could have no definite knowledge of the object from which the light proceeded. Photographers obtain a picture of a person by the use of a plate of glass on which is a film sensitive to light. This sensitive plate is placed in a box or camera, facing the person. But were the camera a simple box with a hole in front through which the light could fall on the plate behind, the result would be a uniform darkening of the film from the exposure to light and no picture would be produced. What the photographer desires is to throw on the plate an image of the person in light and shade. The parts of the sensitive film on which the light portions of the image fall are strongly acted on, and the parts on which the shadows fall are feebly acted on, and more or less feebly as the shadows are deep or slight. The sensitive plate is thus unequally acted on, and when the photographer has submitted it to the action of certain chemical solutions the film is left thick and dark where the strong light fell, but thinner and more or less transparent in the places corresponding to the shadows. If then he holds his plate up to the light and looks through it, he sees in light and shadow an image of the person who sat before the camera. But to obtain this there must be certain definite parts of the sensitive plate corresponding to certain parts of the person. Thus if the light is shining strongly on one side of the person's face, the sensitive plate must receive the rays reflected from that part of the face, and these rays must not be diffused over the whole plate, but made to fall on a part of the plate corresponding accurately in outline and in proportionate size to the part from which they have proceeded. So it must be with the rest of the figure. On the plate there must be parts corresponding to the parts of the person to be photographed. It is the same in vision. If not merely a general impression of light is to be obtained, but a definite knowledge of things, then on the retina there must be distinct luminous impressions, distinct regions of light and shadow corresponding to the lights and shadows of the object from which rays of light are proceeding to the eye. In short, we cannot see in absolute darkness, we see only when light enters the eye, and we see definite things only when rays of light fall on them and are by them reflected into the eye. If all objects reflected

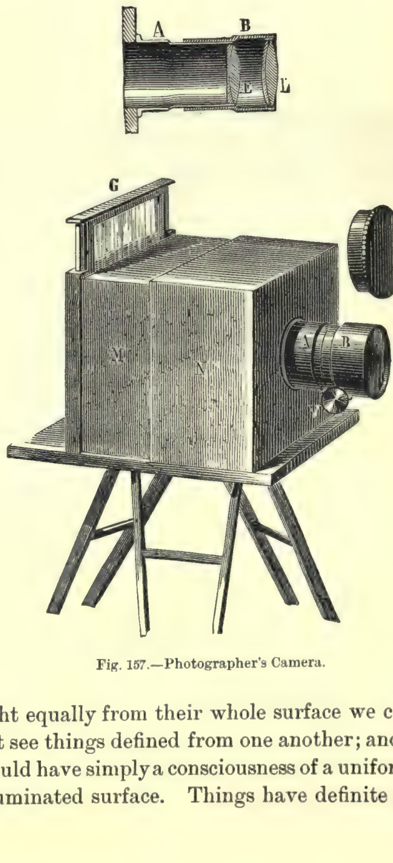


Fig. 157.—Photographer's Camera.

light equally from their whole surface we could not see things defined from one another; and we would have simply a consciousness of a uniformly illuminated surface. Things have definite out-

lines, and forms, because light is unequally reflected from different parts of their surface, the illuminated object being mapped out by the shadow that surrounds it. It is only, then, when such illumination and shadow are accurately reproduced on a sensitive photographic plate that an image of a person or object is obtained, and only when accurately reproduced on the sensitive coat of the eye that we can see things distinctly. How then is this accurate reproduction of light and shadow obtained? Let us examine the photographer's apparatus, for in it is an accurate representation of the eye.

The photographic camera is a box (M N, Fig. 157), the inner surface of which is painted a dull black, and which is light-tight. In front is an opening into which is screwed a brass tube (A B) fitted with a series of convex lenses, shown in the upper part of the figure (E L). A screw (V) enables the tube containing the lenses to be worked backwards or forwards in an outer case. The box is closed at the back by a ground-glass plate (G), capable of being removed. No light enters the box except through the opening in front (which may be closed by a cap), and it must pass through the lenses on its way.

The effect of a convex lens is exhibited in Fig. 158. It brings rays of light passing through

Fig. 158.—Effect of a Convex Lens.

it to a point or focus (F) by refracting or bending them out of their course. Now suppose that the object from which the light is reflected is an arrow, as in Fig. 159. The rays of light from the point of the arrow (A) are acted on by the lens and brought to a focus at *a*, the rays from the other end of the arrow are focussed by the lens at *b*, and rays from every other point of the candle are focussed at corresponding points between *a* and *b*, so that rays from every point of A B have corresponding points in the line *a b*. In short, an image of A B is produced at *a b* through the agency of the convex lens, but the image is upside down, because, as we see, *a* is the image of A, and *b* of B. Now if at *a b* a screen were placed, and if all light except that passing through the lens

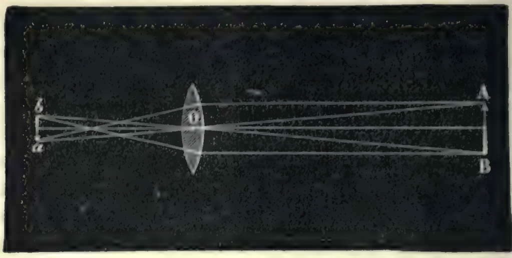


Fig. 159.—Formation of an Image by a Convex Lens.

were prevented falling on the screen, a bright distinct image of the arrow would be seen, but smaller than the real object and upside down. The conditions would be accurately fulfilled if the screen were on the back wall of a black box which had an opening in front in which was fixed the lens. But this is just a camera with its ground-glass plate as screen. The inside of the box is blackened to prevent reflection of light which would mar the distinctness of the image. Now from Fig. 159 it will be evident that if A B were brought nearer to the lens, its image *a b* would not be found in the same place. It would be further removed. The screen would require to be moved back a bit. Suppose the screen were immovable, the lens might be altered in position so as to bring the focus once more on to the screen. If the lens could not be moved, nor the screen, the new position of AB would cause its image to fall behind the screen. If another lens were placed in front or behind the original one its action would be strengthened, the rays would be brought to a focus sooner, and if the added lens had the proper degree of convexity (of thickness in the middle) the image would be brought forward so as to make it once more fall on the screen. Now in a photographer's camera the screw which moves the lenses backwards or forwards in their outer tube is for the purpose of bringing the focus always on the ground-glass plate. Usually also the box is made so that it can be lengthened or shortened to effect the same purpose, for the lenses always remain the same. Another thing remains to be noticed about the photographer's camera. Lenses focus more quickly rays of light passing through them near the circumference than those passing through the centre. Both sets of rays are not focussed at the same point. If the rays come

from an object, the image produced is not definite, because all the rays of light are not equally focussed. Now in a camera this is corrected by the use of a stop or diaphragm. It consists of a plate of metal with a hole in the centre. This is passed through a slit in the metal tube between the lenses. It cuts off the outside rays, the centre ones only passing. The holes are made of various sizes to suit the amount of light. By means of the stop an element of confusion is removed and the image made very distinct.

Now if this description of a photographer's camera be applied to Fig. 154 it will be evident how accurately it represents the purposes of the eyeball. The eyeball is a chamber with compact walls into which light can pass only through a clear portion in front (the cornea). Like the camera the eyeball has a dark coat to prevent reflection of light, the dark choroid. Towards the front is a lens—the crystalline lens—through which all rays of light that enter the eye must pass. The lens focusses the rays as any ordinary lens would do. But the action of the lens is aided. There are several refractive substances forming the eye. The cornea refracts slightly, so also does the aqueous humour filling the anterior chamber, and the vitreous humour filling the posterior chamber does so to a greater extent than either cornea or aqueous humour. Thus the moment rays of light enter the eye they begin to be bent out of their course, and the result of the action of the lens, aided by the cornea and aqueous and vitreous humours, is that rays of light that are parallel when they fall upon the eye are brought to a focus on the back wall. If then an object is a long distance off, rays of light proceeding from it and falling on the eye are brought to a focus on the back wall of the eye, and there will be produced a small image of the object *upside down* (Fig. 160). Suppose the object is brought near, then, as we have seen with a lens, the image would fall beyond the wall of the eyeball. To secure that it fall on the wall exactly, one of three things is necessary, as we have seen, the wall must be moved further back, or the lens must be capable of movement, or there must be some way of increasing the focussing power of the lens, so that the rays are sooner brought to a focus, and thus made, once more, to fall on the wall. In the eye it is the convexity of the lens that is altered, and by this means the eye is capable of accommodating itself to different distances, as it is phrased.

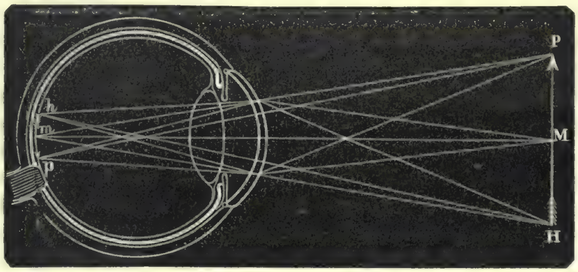


Fig. 160.—Formation of Image on the back of the Eyeball.

Rays of light proceed from the points P, M, H of the arrow and are focussed by the lens and humours of the eye to form an image, p, m, h, which is smaller than the object and inverted.

Accommodation of the Eye to different distances. We are continually moving our eyes from object to object, now looking at something at a distance, now at something near, and again at something far off. To see each thing distinctly the eye must be capable of altering itself with great precision and rapidity to suit the varying distances. The lens is a very elastic body, as stated on p. 340, and is confined within a capsule which presses upon it, and flattens it somewhat. But the pressure of the capsule may be relaxed by contraction of the ciliary muscle (p. 340), so that the lens bulges forwards and becomes more convex. When we look at a near object the ciliary muscle contracts, the capsule relaxes, the lens bulges forwards, the rays of light are thereby more refracted and the image of the object is distinctly produced on the back of the eyeball. When the object is nearer, the ciliary muscle contracts more, and the lens becomes still more convex. When the object is far away, if the lens were to remain as before, the image would be formed in front of the back of the eyeball, and, therefore, the ciliary muscle relaxes, the capsule tightens, the lens is flattened slightly, refracts less strongly, and the image is formed on the back wall as before.

Normal or regular **Sight** exists when the degree of convexity of the lens and the length of the eye are such that rays of light coming from a distance are brought to a focus on the retina—the lining of the back of the eye—*without any effort of the eye*, the eye remaining at rest. Practically all objects at a distance of about 70 yards and upwards from the eye require no effort of accommodation. This distance from the eye is the far point at which the need of accommodation

ceases, and it has been called the *punctum remotum*, or far point. As soon as an object comes nearer than that, the lens must begin to become more convex, and the nearer the object comes the more does the lens increase in convexity by the contraction of the ciliary muscle, till the object is so near that every effort is made to produce greater contraction and thereby greater convexity, and a sense of straining is experienced. A point is at last reached so near to the eye that no further accommodation can be effected, and, if the object is brought nearer, it is no longer distinctly seen. This point is the *punctum proximum* or *near point*, and for the ordinary eye the distance is about six inches. In other words, from an object distant 75 yards and upwards from the eye reflected rays of light falling upon the eye, and passing through its lens, humours, &c., come naturally to a focus on the retina and form an image there, without any effort of the eye. Rays from an object any nearer than that would be focussed behind the eye were no effort made, but by the arrangements for accommodation the lens becomes more convex and the rays are focussed sooner, so that they again fall on the retina. As the body comes nearer and nearer the effort on the part of the eye to focus the rays becomes greater and greater till no greater effort can be put forth, and if the body be nearer than six inches the effort is not sufficient, the lens cannot become convex enough, and thus the rays are no longer brought to a focus on the retina, and in consequence the body can no longer be distinctly seen.

Long-sight (*Hypermetropia*).—If the arrangements necessary to secure distinct vision when a person looks at objects at varying distances from the eye be understood, the defects of the eye, termed long-sight and short-sight, will be readily comprehended. We have seen that in ordinary conditions of the eye, rays of light from distant objects form a picture on the retina without any effort on the part of the eye. Now suppose the distance between the back wall of the eye and the front is less than usual, other things being usual, rays of light from far-off bodies will reach their focus not on the retina, as they ought to, but behind it, because the retina is not so far back as it ought to be. (Refer to Fig. 161.) If the difference from the normal be slight, the person is able to correct it by a slight effort of accommodation. By this slight effort the lens becomes more convex, brings the rays sooner to a focus, and thus brings the picture forwards so as to make it fall on the retina, when the object is distinctly seen. The effort required may be so slight that for a long time the person is unaware of it. But the meaning

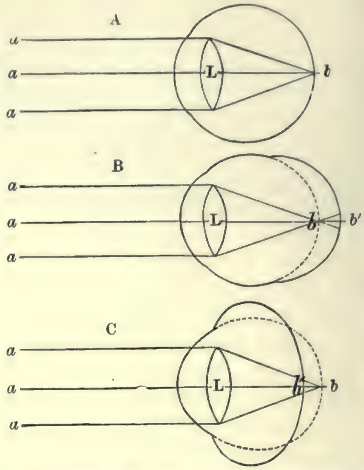


Fig. 161.—A, Ordinary Eye, rays of light *a a* from a distance coming through the lens L to a point *b* on the retina. B, Short-sighted Eye, rays from a distance coming to a point *b in front* of the retina *b′* C, Long-sighted Eye, rays from a distance coming to a point *b behind* the retina *b′*. L is the lens in each case.

of the condition is, that even when the person is looking at far-distant things, which in ordinary circumstances he should see distinctly without any movement of the lens, even when looking at these far-off things his eyes are not at rest, but require to focus to make the image fall on the retina. As the object comes nearer the amount of focussing required becomes greater, and the power of accommodating the eye to see distant objects, having begun sooner than is usual, is sooner exhausted. That is, the eye becomes unable to focus any further before the object has come so near the eye as is usual. Thus a person with long-sight is unable to read a letter or newspaper, let us say, when it is held the ordinary distance from the eye, because his focussing power has failed sooner than is customary. He, therefore, holds the paper or letter farther off from his eye than ordinarily is done. The "near point" is farther away from the eye than in ordinary sight. The defect is called "long-sight" on this account. The remedy is evident. Suppose it is at twelve inches from the eye that the power of the lens to become more convex fails, by placing in front of the eye a spectacle whose surface is convex—rounded—the lens is aided, the focus of the rays is brought forward, and the person can now hold his letter or paper nearer and yet see distinctly. (Refer to B. of this section.)

The accommodation of the eyes of a long-sighted person is never at rest. The result is that in time a feeling of strain and soreness is produced, and the eyes become red and watery, especially when the person reads, writes, sews, or performs any fine work, since, the nearer the object is, the more effort is required to see it distinctly.

Short-sight (*Myopia*) is the opposite condition to the former. The distance between the back and front of the eye is greater than usual. When the person looks at distant objects, the focus does not fall on the retina as in ordinary sight, nor yet behind the retina as in long-sight, where the distance is less than usual, but it falls in front of the retina. (Fig. 161, c.) It is plain that the person can do nothing to correct this. His eyes are at rest, and yet the focus is in front of the retina. Any effort of accommodation would make things worse, by making the lens more convex, and bringing the image still farther forwards. If the lens could be flattened so that the rays were not brought to a focus so soon, distinct vision would result, but there are no arrangements for doing this. The eyes are at rest, and in this state the lens has its least degree of forward curve. Now as the object looked at comes nearer and nearer the focus gradually passes back till at length it falls on the retina, and the person then sees the object distinctly. Thus a short-sighted person cannot see persons or things distinctly at a distance. Moreover, a short-sighted person sees distinctly, and without any accommodation by his eyes, that is, his eyes being at rest, an object at the distance for which a person with ordinary sight requires to focus strongly. That is to say, the short-sighted person does not require to bring into play the arrangements for accommodation so soon as the person with ordinary sight, and thus the accommodation of the person with ordinary sight is exhausted before that of the short-sighted person. Thus, when the ordinary individual has brought printed matter so near his eyes that if he holds it any nearer it is no longer distinct, the short-sighted person can bring it much nearer and still see it distinctly. Indeed to see it distinctly he requires to hold it nearer than the ordinary reading distance. On this account the defect is called "short-sight." It is thus evident that the short-sighted person cannot by any means see things at a distance distinctly, because the picture does not fall on the back wall of the eyeball; on the other hand he sees things very much nearer than usual. To correct this some arrangement is required which will prevent the rays of light coming so soon to a focus, by which means the image will be produced further back and made to fall on the retina. A concave spectacle—one hollow on the surface—does this, for it slightly disperses the rays, and they are brought to a point later than they would otherwise be. (Refer to B. of this section.)

The Movements of the Eyeball.—The eyeball is controlled by a set of six small muscles, which, with one exception, are attached to the back part of the cavity in which the eye rests. The muscles pass forwards and are connected by thin flat tendons to the outer coat of the ball, a short distance behind the clear part of the eye—the cornea. Four of these muscles run a straight course, and are called **recti muscles** (Latin *rectus*, straight). One is attached in the middle line above, another below, and one to each side of the eyeball. They are, therefore, called superior, inferior, internal and external. Acting alone one would turn the eye upwards, another downwards, the third inwards, the last outwards. The other two muscles bend in their course, and are called **oblique muscles.** One arises behind in common with the four straight muscles, and passes to the front towards the inner angle of the socket, there it ends in a round tendon and passes over a tendinous pulley. From the pulley it changes its course, proceeds over the eyeball slightly backwards and becomes attached to the ball at its outer side. When it contracts, acting round the pulley, it rolls the ball. Since it proceeds over the eye it is called the **superior oblique muscle.** The other oblique muscle is below—**inferior oblique.** It springs from the lower part of the inner angle of the socket and passes below the ball towards its outer side where it is attached. When it contracts it also rolls the eyeball, but in an opposite direction to the superior oblique. These oblique muscles do not act alone, but in association with one or other of the straight muscles. In combination they produce the varied movements which the eyeball can so freely perform.

As a rule both eyes are moved at the same time in the same direction, so as to regard the same object. When one muscle becomes paralysed so that the eyeball cannot be turned in that direction, the two eyes no longer act together, when the person seeks to look that way. The sound eye is turned far enough, the other fails to go round. Squinting is produced, and

the particular object looked at is seen double. As soon as the eyes are turned in other directions, they again act together, the squint disappears and the vision is single. (Refer to **Double Vision**, p. 350.)

The Information gained by the Eyes.— It may be well to state here briefly the substance of the foregoing paragraphs. The eye is to be regarded as the peculiar form of ending of the optic nerve, designed to be affected only by light, and so excited by light as to send on to the brain an impression which there gives rise to a sensation of light. It is supplied with a series of structures that act as convex lenses, which so focus rays of light, passing through them from external objects, as to form small images of these objects on the retina, the nervous coat that lines the inner surface of the back chamber of the eyeball. Now the first thing to notice is, that it is this image on the retina that produces the sensation of seeing something, and yet we are not conscious of the image on the retina but only of the outward thing from which the rays of light proceed. This is difficult to understand. It is doubtless the result of education. We learn that the things we see are the result of impressions reaching us from the outside, and we refer the object from which the impressions reach us outwards in the direction of the straight lines in which the rays of light fall upon the eye. Thus, it is related of a patient, who was blind from his birth owing to cataract, that when sight was restored by an operation, performed by the English surgeon Cheselden, he thought all objects he saw touched his eyes. His other senses corrected his mistake. He found when he put his hand up that the objects did not touch his eyes, that he had to walk towards them in order to touch them, &c. Thus he trained his eyes by means of other senses, and in other ways, to appreciate the distance from him of the objects he saw. Again, the brain of the man suffering from delirium tremens is disturbed and excited by what he has drunk. The seeing centre in the brain is aroused by the stimulant and perverted by it, and he becomes conscious of images so produced, and believes them to represent actual existences. The creatures that leer at him, and crawl over him, and dance before him, are the creations of his excited brain, but his judgment is also perverted, and he is unable to perceive that they have no real objects corresponding to them in the external world. Again, when pressure is exerted on the eyeball, or when a sudden blow is received on the eyes, the nervous apparatus of vision is excited and colours or bright sparks (called **phosphenes**) are seen, which only experience teaches to be due to internal disturbances. The production of what are called **Purkinge's figures** is another example of the same thing. If a person goes into a dark room with a lighted candle, and, facing a blank plain-coloured wall, holds the candle to the side of the head, moving it up and down, the appearance of branching lines will be seen on the wall. These are shadows of the blood-vessels of the retina (p. 341). The sensitive portion of the retina (the layer of rods and cones) is behind the blood-vessel layer, and thus the lines of vessels intercept the light passing in at the extreme side of the eye, the shadows produced appearing to the person to be something outside. Then it is well known that minute floating bodies in the humours of the eye produce shadows which to the person seem to float across his vision in space. These are called **muscæ volitantes.** It is then only by a process of education, in which the various senses take part, that a person learns to judge of the actual existence of an outward object corresponding to his sensation. It may be remarked that a similar explanation applies to **hallucinations.** This is the term given to things a person seems to see for which there is nothing externally to account. There are undoubted cases on record where an individual has seen a person or thing in the immediate neighbourhood, and by going up to the place has assured himself that nothing but simply space existed there. Sir David Brewster gives a case, in his *Natural Magic*, of a lady who on entering the drawing-room saw her husband standing on the hearth-rug with his back to the fire. She addressed him and sat down in a chair within two feet of the figure. After she had again spoken, the figure moved off to the window and then disappeared. Frequently afterwards she had similar experiences, seeing other persons and things, in the presence, on one occasion, of her husband, who assured her that the cat she saw sitting on the rug at his feet had no actual existence. She herself had the courage more than once to convince herself that the appearance was a deception by sitting down on the chair on which she saw someone sitting, when the appearances vanished. In these cases changes were excited in the nervous apparatus of vision not due to any outward existence, though as a rule only produced by such, and the lady was consequently

for the time deceived, until she had corrected her sensations by other means.

Another thing to be noticed is that the image on the retina is upside down, and yet we see things in their upright position. When we direct our eyes towards a particular object rays of light pass into the eye not only from that object but from other parts in its immediate surrounding, and we become conscious not only of the particular object we are looking at but of a region round about it. This region is called the **visual field** or **field of vision**. Now rays of light coming from the left of the field of vision fall on the right side of the retina, rays from the upper part of the field fall on the lower part of the retina, rays from the lower part of the field on the upper part of the retina, and so on. We refer the image on the lower part of the retina in the direction from which the rays come, that is, towards the upper part of the field of vision. Moreover we interpret by means of touch, for, to reach with the hand the part of the object whose image is on the lower part of the retina, we must raise the hand, and to touch the part of the object whose image falls on the right side of the retina we must pass the hand to the left side, and so on. Thus though the image is upside down on the retina, we see the object upright.

The **estimate of size** given by the eyes depends on the angle formed by the rays of light before crossing in the eye. This is explained by Fig. 162. From the object PAH, rays P*p*, H*h* pass to the eye. At O they form an angle POH. This is the visual angle, the angle under which PAH is seen. PAH forms an image *ph* on the retina, and its apparent size is dependent upon the angle at O. But the lines P′BH′ and P″CH″ are seen under the same visual angle, and will,

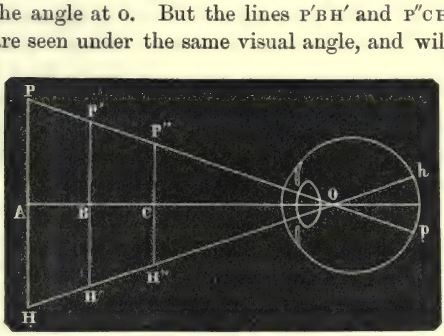


Fig. 162.—The Visual Angle.

therefore, have the same apparent size, and form images of the same size on the retina. To this impression, however, there remains to be added the idea of distance. We know that as objects pass farther and farther away from us they appear smaller and smaller, and as they approach they become larger. If, therefore, an object at a great distance off appears as large as an object very near to us, we judge the far-off object to be much more extensive than the near one.

Our **appreciation of distance** is guided to a large extent by the clearness with which the object looked at is perceived and its details made out. If the atmosphere be very clear, mountains at a distance appear nearer than they do when the atmosphere is hazy. An artist gives an impression of distance to the objects in the background of his picture by the want of distinctness of their outline and detail. It is very difficult, however, to judge absolutely of distance. Between us and a distant object a great many other objects intervene, whose distance from us we can more readily estimate. We thus guide ourselves in forming an idea of the distance of the far-off object by the others which are between, and which afford us something to measure by. Thus everyone knows the errors easily made by sailors at sea in judging of the distance between their ship and another, because of the absence of anything between to aid the vision.

For various reasons, therefore, judgments

Fig. 163.—Judgment of Distance.

formed by vision of the real size and distance of things are not too reliable. A good illustration is given in Fig. 163. The distance between A and B seems greater than the distance between B and C, and yet it is the same, the apparent increased space between A and B being due to the markings between. For the same reason, of two squares absolutely identical in size, one marked with alternately clear and dark cross-bands, and the other with alternately clear and dark upright markings, the former will appear broader and the latter higher than the other. Thus a short stout person whose dress is cross-striped or made with flounces appears stouter than she really is, and a tall woman whose dress has upright markings or folds that run up and down exaggerates her length. Consequently a stout person who wants to increase her apparent height and diminish her apparent stoutness should wear dresses striped or folded up and down, and a tall person who wishes to diminish her apparent tallness and to appear stouter should wear cross-marked or folded dresses.

Single Vision with Two Eyes. When we look at an object with both eyes, it appears under ordinary circumstances as a single object. Two images of the object are produced, however, one on the sensitive coat (retina) of each eye, though we are not conscious of two images. If now a finger be pressed strongly on one eyeball so as slightly to push it to one side, the object will appear double; when the pressure is removed the object is again single. It seems, therefore, that single vision with two eyes is produced when the image of an object falls on the corresponding part of each retina. If one eye be so displaced that the image falls on a part of its retina that does not correspond to that of the other eye, then the object appears double—**double vision**, as it is called, is produced. In looking from one object to another the eyes are moved together in harmony with one another, and single vision is constantly secured. If, however, a person suffers from paralysis of one of the muscles of one eyeball, then it is evident that when the eyeballs are moved in a particular direction the paralysed muscle will be unable to contract, will be unable to pull the eyeball round in that special direction, and thus, while the eyeball, whose muscles are all sound, is properly directed to the object, the other one cannot be sufficiently brought round, the image of the object will not fall on corresponding points of the two eyeballs, and double vision will result. Since only one muscle is affected, the eyeball can be moved quite freely in every direction but one, and thus in all other directions single vision will be produced, because in all directions but one both eyeballs will act together. Persons who squint would also "see double" were it not that they accustom themselves to use only the straight eye, and speedily become altogether unconscious of the image on the squinting eye.

Single vision with two eyes, that is **binocular vision**, enables us to judge of the solidity of objects looked at. The image that falls on each eye is not absolutely the same, because each eye regards the object from a very slightly different point of view. The two images, differing so little from one another, are fused together in our consciousness; but the result of the slight difference is to give us a particular impression which experience has taught us is due to the object being not flat but raised—we have, that is, the impression of a solid body. This may be illustrated by a very simple experiment. Fig. 164 shows two views of a cube; the view on the right hand presents the appearance that would be perceived suppose a cube were looked at by the right eye, while on the left hand is the appearance of the cube to the left eye, the position of the person not

Fig. 164.—Stereoscopic Views.

being changed. Now let one take a card about 10 inches long and hold it between the two views, let the person rest his forehead on the upper end of the card and look on the figure, so that the left eye sees only the left view and the right eye sees only the right view; with a slight converging of the eyes only one cube is seen, but it is neither the right-hand nor left-hand view, but a view produced by an overlapping of the two, and the cube stands out from the paper as if it were actually a solid body.

This is the principle of the **stereoscope**, Fig. 165. It is a box divided into two sides by a

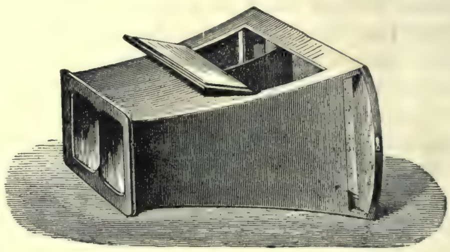


Fig. 165.—The Stereoscope.

thin partition down the centre. In the bottom of the box is placed a card on which are pasted two photographs of the same thing. Each photograph, however, has been taken from a slightly different point of view, so slightly different that, without careful examination, one would conclude they were both absolutely the same photographs. The views are of such a size that each one extends across the space in the bottom of its compartment, and the central partition accurately separates the two. At the opposite end of the box are two lenses, so placed that when the box is held up to the eyes each eye looks through one lens. Looking through the glasses each eye sees a photograph, slightly magnified. The lenses are of such a shape that they cause a slight displacement of the pictures, so that the images fall on corresponding points of the two eyes. The two images are fused together, and one becomes con-

scious of only one picture, in which the objects stand out in relief, just as they would appear were one looking at the actual objects themselves.

Colour. Ordinary sunlight appears to be compounded of seven different colours: red, orange, yellow, green, blue, indigo, and violet. If a wedge-shaped piece of crystal—a prism—be held up between the sunlight and the eye, these various colours will be seen, because the prism separates the white light into its constituent colours. The band of the different colours produced in this way is called a spectrum—the spectrum of sunlight. The rainbow is such a spectrum. The same thing can be shown in another way. If the seven colours be painted

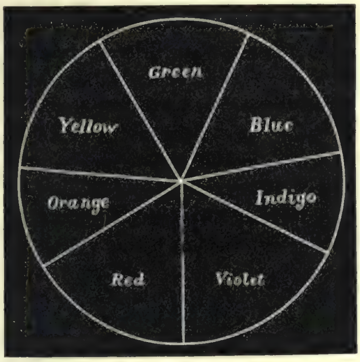


Fig. 166.—Rotating Disc of Sir Isaac Newton for mixing Colours.

on a wheel as indicated on Fig. 166, and in proper proportion, and the wheel be turned on a pivot through its centre with great rapidity, the eye will not perceive any colour at all, but the wheel will appear a dull white. If, however, one of the seven colours be omitted, the revolving wheel will be no longer white. The six remaining colours will still be fused together, so as to give the impression of one colour—the result of the union of the six.

Now bodies appear variously coloured because of their behaviour to white light. Some bodies held up between the light and the eye permit all the rays to pass through, and therefore appear without colour, other bodies do not permit all the rays to pass, they intercept some. Thus one body keeps back all rays but the red; they alone pass through, and thus the object appears red. Another body keeps back all the rays but the yellow and some of the red, and it appears to be orange. A third body permits only the violet rays of white light to pass, and it, therefore, appears violet, and so on. Again another class of bodies do not permit rays to pass through them, but they reflect rays. Their apparent colour depends upon whether they reflect white light unchanged, or whether they reflect only some of the seven different rays of white light and retain or absorb others. A body that reflects the white light unchanged appears white, a body that does not reflect it at all, but absorbs it, appears black. One body absorbs all rays of white light except red, these it reflects and it appears red in consequence. If you throw a beam of red light on such a body, say a piece of red ribbon, it reflects the rays and appears brilliantly red. But throw a ray of yellow light on the red ribbon, it does not reflect but absorbs yellow light; in consequence it appears no longer bright coloured, but almost black. An orange ribbon reflects partly red and partly yellow rays of white light, the others it retains, and it therefore appears orange, that is a blend of red and yellow.

It has been said that the seven different colours of the spectrum, painted in certain proportions on a wheel which is turned with great rapidity, will produce the impression of white. It has been found that these seven separate colours are not required, but that the impression of white can be produced by three colours only, viz.:—

Red.
Green.
Violet.

These three painted in proper proportion on a wheel will give the impression of white. Moreover, all the seven colours of the rainbow can be produced by varying the proportion of these three colours. On this account they are called the **fundamental colours.**

Complementary Colours are not to be confounded with the fundamental. There are certain pairs of colours which when blended produce a sensation of white. Thus:—

Red	and Blue-Green	produce	White.
Orange	,, Blue	,,	,,
Yellow	,, Indigo-Blue	,,	,,
Green-Yellow	,, Violet	,,	,,
Green	,, Purple	,,	,,

That is to say, given red, the other colour required to produced white is bluish-green; or given bluish-green, the other colour required is red, and so on. These colours are therefore said to be "complementary" to each other, because they together produce white.

Here a mistake must be guarded against. It must not be supposed that it is meant that

a mixture of paints of these colours will produce a white paint. A red powder and a bluish-green powder will not produce a white one, as everyone knows, nor the mixture of red and bluish-green liquids. But if, at the same instant, the eye be affected by red and bluish-green light, the sensation is not of either colour, but of white. It is the sensation that must be mixed, so to speak, and the mixed sensation is not produced by a mixture of the differently coloured powders or liquids.

The Perception of Colour by the eye is explained by a theory first proposed by Thomas Young, and afterwards more fully worked out by the German professor, Helmholtz. According to that theory there are in the eye three sets of nerve-fibres capable of being excited by the fundamental colours (see above). One set is excited by red light, another by green, and another by violet. Just as the different colours of the rainbow may be produced by various proportions of these three colours, so may different sensations of colour be produced by the excitement of these three sets of nerve-fibres in different amounts. Thus, when all the three sets of fibres are nearly equally excited, there is a sensation of white. Red light will strongly arouse the nerve-fibres sensitive to red, and will barely affect the other two. Yellow light will moderately excite the fibres sensitive to red and green, and not those sensitive to yellow, and the result is not a sensation of red or green, but of yellow. Blue light excites moderately the fibres sensitive to green and violet, and barely affects those sensitive to red, and there is a sensation of blue. This theory would account for colour-blindness. Thus, if the fibres that ought to be sensitive to red, for some reason or other did not respond at all, the person would be unable to perceive red. (Colour-blindness is considered at length in the second part of this section.)

After-images are also explained by the theory of colour and its relation to the perception of colour. If, on awaking in the morning, we look *for an instant* towards a window through which bright sunlight is streaming, and then turn away the head and shut the eyes, we are aware of an image of the window, in which the panes appear white and the sashes, &c., dark, as they appeared when actually looking at them. This is a **positive after-image,** and is due to the fact that, the sensitive coat of the eye being highly excitable by the long rest of the night, the effect of the stimulus of the light lasts even after the exciting cause has ceased to operate. If, however, we gaze *for a time* at the window and then look away and shut the eyes, or look towards a dark part of the room, we see an image in which the light and dark parts are reversed, the panes being dark and the sashes white. This is a **negative after-image.** It is due to the sensitive coat of the eye being fatigued in certain parts. The parts corresponding to the panes, on which the strong light fell, are exhausted and appear dark, while the parts corresponding to the sashes, on which the light did not fall, are still unexhausted and therefore appear light. In a short time the retina recovers and the experiment may be repeated.

Now, suppose we look fixedly for a short time at a white sheet of paper on which is a red spot, a bright light falling on the paper, and then turn the eyes to a plain white sheet of paper or to a white wall, an image of the spot will appear to float before the eyes, but it will not be a red image but bluish-green. The explanation of this is similar to that of after-images. The sensitive coat of the eye has been exhausted, but not to all the constituents of white light, only to the red. The result is that an after-image floats before the eyes, whose colour is that of white light less the red, in other words, the colour which with red goes to make up the sensation of white, the complementary colour of red, namely bluish-green. Similarly if the spot gazed at has been bluish-green, the after-image will be red. If the spot be orange the after-image will be blue, &c. The experiment may also be varied. Thus a large red spot may have a name written across it in another colour, in which case the after-image would show a bluish-green ground and the name would be in a different complementary colour.

HEARING.

The Nature of Sound.

Sound is a form of movement. This may be shown in various ways. We all know that a tightened string may be caused to give out a musical sound by being pulled strongly to one side and then let go. The string makes a rapid to-and-fro motion, which is accompanied by the sound. As the motion becomes less vigorous the sound becomes feebler, and when the movement stops the sound also ceases. The limbs of a tuning-fork are in rapid motion when it is

sounded. In the case of very large heavy forks the to-and-fro movement can be seen; but in the case of small forks, such as those used by musicians, the motion is so fine and rapid that it is not visible. When a bell sounds, after being struck, it can be shown to be in motion; not moving as a whole, but the particles of which its mass consists being in rapid vibration. Now suppose we have a small bell, the hammer of which is worked by clockwork; let us place it on the plate of an air-pump, resting on a thick cushion of felt; and let it be covered with the glass bell-jar of the air-pump. If the clockwork be working we still hear the sound through the glass. Now let the pump be worked so as to remove the air from the chamber, and as soon as a considerable quantity of air has been removed the sound becomes very feeble. When the glass jar has been as completely exhausted of air as possible, the sound is no longer heard, though the hammer may still be seen to strike the bell. The stroke still causes vibrations of the particles forming the substance of the bell, but owing to the absence of air there are no means of communicating the vibrations to the ear of anyone in the neighbourhood. This shows, then, that sound is a movement, that it is only when the movement is conveyed to the ear and affects the nerves of hearing that the sensation of sound is produced, and that it is usually the atmospheric air that acts in conveying the motion to the ears.

The sound movements, or vibrations, as it is better to call them, are conveyed through the air in a wave-like fashion, represented in Fig. 167. The figure shows a tuning-fork, supposed to be sounding. Its limbs are, therefore, in a state of rapid vibration. In the figure what occurs is shown only on one side. The limb a moves to and fro, now in the position a', and now in the position a''. When the limb moves from a to a' the air in contact with it receives a shock, and the particles of the air are crowded together by the blow. When the limb moves from a' to a'' the particles that were crowded together have now more space at their disposal, and are less crowded than before the shock of the limb. But with great speed the limb moves back from a'' to a', and again the particles are crowded, and then it rapidly returns to a'', where the greater space is again created. Thus, while the fork continues to vibrate, the particles of air in its immediate neighbourhood are at one moment crowded together, at another moment the opposite is the case, and this goes on on each side of the fork as long as its movements continue. The crowding together of the particles of air by the shock of the fork is called a *condensation*, and the opposite movement a *rarefaction*. To use these terms, then, the air on each side of the limb of the fork is at one moment in a state of condensation and at another moment in a state of rarefaction, in time with the vibrations of the fork. But this peculiar agitation is not confined to the air that is in immediate contact with the fork. The condensation travels outwards from the fork through the atmosphere, and the rarefaction likewise; and as long as the fork keeps going these two conditions are passed along through the atmosphere from the sounding body, which thus becomes a centre of disturbance, just as a stone thrown into still water imparts a shock to the water, and from the place where it struck waves pass outward on all sides. Fig. 167 represents by the difference in the shading the alternate condensation and rarefaction. Now we all know that a person in a boat on the water will become aware of the agitation of the water, even though at a distance from the centre of disturbance, by the waves rippling up to him. Even so a person becomes conscious of a disturbance in the atmosphere, though he be at a distance from the place where it is produced; because the waves of condensation and rarefaction, spreading outwards on all sides from the vibrating body, at length reach him and beat upon him. They affect his ears, they irritate his nerves of hearing, and so he becomes aware of what he calls sound. If we could see air as we see water, we would perceive the disturbance, caused by a sounding body, passing through it.

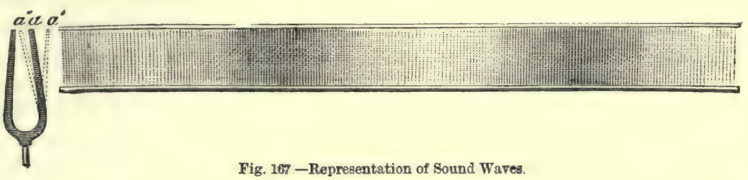


Fig. 167.—Representation of Sound Waves.

It takes a certain time for sound to travel. The rate is about 1090 feet per second when the temperature of the air is 0° Centigrade, and is increased when the temperature is raised. Everyone who has watched the discharge of artillery from a distance knows that the flash and smoke from the gun's mouth are perceived a brief time

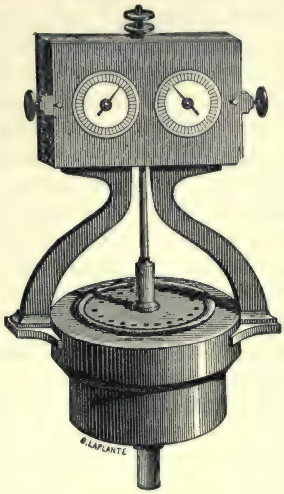
before the report is heard. If the interval between the two be taken, remembering the rate at which sound travels, one may readily make a rough estimate of the distance of the gun—allowance, of course, being made for wind. Now if the atmosphere were visible, with the gun's discharge, a tremendous disturbance would have been seen to take place in the air at the gun's mouth at the moment the flash was seen. This disturbance would be seen spreading outward in all directions and travelling with great rapidity. Suppose the person stood watching the advancing agitation, then, just at the moment when it reached and enveloped him, he would hear the report. So that when a person walks through a crowded and noisy thoroughfare, his ear is being assailed by numberless waves of sound of all kinds and sizes and degrees of rapidity, that surge and swell in the atmosphere around him.

There are various characters of sounds which it is necessary to have some idea of for the proper understanding of the apparatus of hearing. These characters are best exemplified by musical sounds, which are distinguished from ordinary sounds by the regular rhythmical character of their wave movements.

Musical Sounds differ in loudness or intensity, in pitch, and in kind or quality.

The **loudness** of sounds depends on the extent of the vibration or movement—the largeness of the wave, so to speak.

The **pitch** of the sound is determined by the number of vibrations that take place in a second of time. Thus a tuning-fork whose limbs move to and fro 100 times a second will give out a sound of a certain pitch, and a tuning-fork that executes 200 movements in the same time will sound a note of a higher pitch—will, in fact, sound the octave of the former fork. This is shown in a very beautiful way by an instrument devised by a Frenchman, Cagniard de Latour, and called a **siren**. It is shown in Figs. 168, 169. It consists of a metal box, the floor of which is pierced by a tube, placed in connection with a large bellows. In the roof of the box is a small round opening, passing in a sloping direction. Fig. 169 shows a piece cut off the box so as to exhibit this opening. Above the fixed roof of the box, but very close to it, is a round plate, with a number of openings pierced in it, which slope in an opposite direction to that of the roof. This plate turns on a



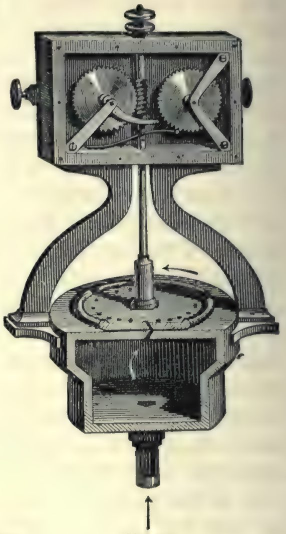


Fig. 168. The Siren. Fig. 169.

fine pivot, so that one hole after another can be brought opposite the opening in the roof. Fig. 169 shows one hole in the plate opposite the opening in the roof of the box, and the different slope of the two openings is seen. Fig. 168 shows the siren complete. Now if air be driven from a bellows into the box, it escapes by the opening in the roof; and as it rushes out it strikes against the edge of the hole in the plate, and the "puff" of the escaping air is heard. The plate, being easily moved, is by this means made to turn, and so the opening in the roof becomes blocked; but when the plate turns a little further a second hole in it comes opposite the opening in the roof, the air again rushes out, produces another "puff," and drives the plate round a little further. Again the opening is blocked, and with the continued turning of the plate it is again speedily opened. If the bellows be worked hard the plate will be driven round fast, and the opening in the roof will be opened and closed very rapidly. Every time it is opened a shock will be given to the atmosphere by the escaping puff of air. Fixed to the apparatus are two dials which mark the number of turns made by the revolving plate. If one knows how often the plate turns in a minute, and the number of holes in the plate, it is easy calculating how many shocks the air will receive in a minute. Now it is found that if the bellows be worked so feebly that the

plate turns so slowly as not to open and close the hole in the roof sixteen times a second, the puffing sound is heard each time the air escapes. But if the hole in the roof of the box is opened and closed sixteen times a second, which would be effected if the plate were turning once a second, and if it were pierced with sixteen holes, then the sixteen puffs are not heard as separate sounds, but are blended together and a low musical sound is heard. If the bellows be worked more and more quickly the plate turns faster and faster, the number of shocks given to the air in a second of time is increased, and the sound is heard to rise in pitch, until with the utmost speed of the plate it becomes a high shrill sound. It is possible, by means of the siren, to discover the number of vibrations made in a second by the limbs of a tuning-fork, sounding a note of a certain pitch. Let the siren be worked till the sound produced is of the same pitch as that of the fork; then by noting the number of times the plate is revolving, as marked on the dials, the calculation may be made. The instrument shows conclusively how pitch of sound depends on the number of vibrations produced by the sounding body in a second of time.

Quality, kind, or **character** of musical sounds depends on something very different from loudness and pitch. We speak of a sound being harsh, or mellow, or rich, &c. We know that a note of the same pitch sounded on a piano, a trumpet, and a violin, differ very markedly in quality, and that a note of the same pitch produced by the human voice differs from them all. Each instrument, that is to say, has a quality of its own. If a tuning-fork of the same pitch be sounded, we are aware of a great difference. The sound might be called thin, or poor, wanting in quality. It is, indeed, so wanting, for a tuning-fork produces what is called a pure sound. But suppose the tuning-fork vibrates 100 times per second, and that we take another vibrating 200 times a second; it will produce a sound the octave of the first. Let us take a third, vibrating 300 times, the octave of the second, a fourth, vibrating 400 times, and so on up to an eighth, vibrating 800 times per second; then we have a set of forks all related to the first, in that they vibrate twice, thrice, four times, &c., as often as the first. If, beginning with the first, they are all sounded one after the other, we perceive the sound of each one immediately after it is produced, but the different sounds immediately begin to blend. When all are sounding we are not aware of eight different sounds, but of one sound of a definite pitch and peculiar quality. The pitch is given by the note of the one with which we began, which is called the **fundamental note**, and the particular quality is due to the blending of the other notes, which are called **overtones** or **harmonics**. The quality may be altered by causing only some of the forks to sound along with the first one; and it is mellow if the forks with fewer vibrations sound, while it is ringing if those with most vibrations are set going. The quality of the sound produced by a violin string is due, therefore, to it vibrating not only to produce the fundamental note to which it is tuned, but also vibrating so as to produce overtones. A piano wire tuned to the same pitch produces a different set of overtones, and thus has a quality of its own, and so with each different musical instrument. In the language of wave movement, the pianoforte wire and the violin string may produce the same *number* of waves in a second of time, but the *form* of the wave is different in each case, and so the quality differs.

These are the chief facts to remember regarding sounds. How the knowledge of them aids in the understanding of the structure of the ear and the perception of sound will be seen immediately.

The Organ of Hearing—the Ear.

The Ear is to be regarded as an apparatus intended to be affected by waves of sound. Connected with it is the nerve of hearing—indeed the ear is to be considered as a peculiar form of nerve ending—so that as soon as the ear is affected by sound the impression is conveyed along the nerve to the brain, and the sensation of sound is produced. Now the nerve of hearing, or auditory nerve, ends in a peculiar structure placed deeply, for protection, in the bones of the head. So deeply is this principal part of the organ of hearing placed that sounds cannot directly affect it. Some arrangement requires to be provided, therefore, for conveying or conducting the sounds inwards towards the nervous structure. The organ of hearing, therefore, consists of two parts:—

1. A part for conveying sound inwards to
2. The nervous portion affected by sound.

The nervous portion is most deeply placed, and is called **the inner ear**; while the sound-conducting portion includes what are called **the outer ear** and **the middle ear**.

The Outer Ear consists of the appendage,

or **auricle**, at the side of the head, and of a passage that leads inwards from it. The outer appendage is of a peculiar shape, which is not without its uses. For it has been shown that waves of sound falling on the outer ear are, owing to its peculiar curves, directed into the passage. The passage, or **external meatus**, is

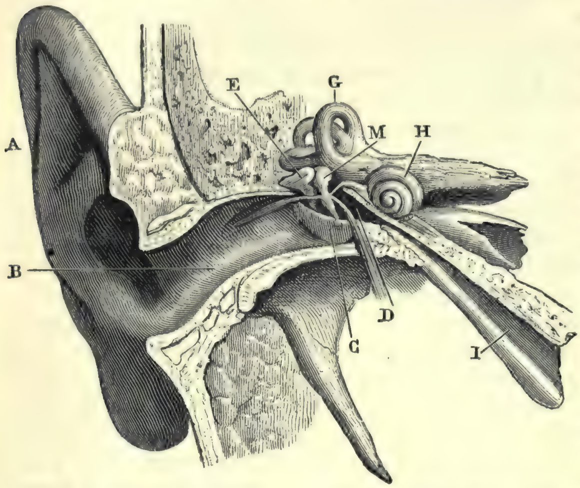


Fig. 170.—The Ear of the Right Side. A, Auricle; B, External canal; C, Drum, partly removed; D, Cavity of middle Ear. E, Anvil, and M, Hammer—small bones of the middle Ear; H, Cochlea, and G, Semi-circular canals of internal Ear. [These latter parts are buried in the temporal bone of the head.] I, Eustachian tube passing from the cavity of the middle ear to the throat.

not straight but curved, and is about an inch and a quarter long. Near its outer portion are a number of fine hairs, which may help to prevent the entrance of insects, &c., while in the deeper parts of the canal, embedded in the walls, are a number of glands, resembling the sweat glands (p. 307) of the skin, which pour out a yellow waxy substance, the **ear-wax** or **cerumen**. This substance keeps the canal moist, and may be produced in excessive quantity—for example, owing to irritated conditions of the walls of the canal, as a result of cold—and the wax may collect in sufficient quantity to block the passage and produce dulness of hearing. It is plain that the business of the outer ear is to collect the waves of sound and conduct them inwards nearer to the inner ear, the true organ of hearing.

The Middle Ear. At the end of the outer ear passage is the **drum of the ear**, or **tympanum**, or **tympanic membrane**. It is stretched quite across the deep end of the passage, which it *completely closes*. It is a thin, unyielding membrane, oval in shape, not flat, but bulging slightly inwards a little below the middle. On the inner side of it is a small cavity, the **cavity of the middle ear**, or cavity of the drum of the ear. This is a small chamber, placed in one of the bones of the head (the petrous portion of the temporal bone, see p. 19), about half an inch in height, and one to two lines in breadth. Its bony walls are lined with mucous membrane—a membrane, that is, similar to that lining the nose, mouth and throat. There are several deficiencies in its walls. In the outer wall an opening in the bone is closed by the drum. The drum, that is to say, is a partition between the passage of the outer ear on one side and the cavity of the middle ear on the inner side. On the inner wall of the chamber are two openings, one round, called the **round window**, or in Latin the **fenestra rotunda**, and another oval, the **oval window**, **fenestra ovalis**. On one side of the chamber is an opening leading into a tube, about an inch and a half long, the **eustachian tube**, partly made of gristle, and lined with mucous membrane similar to that of the chamber and the throat. This tube passes downwards into the back part of the throat. The tube is usually closed, but it is opened in the act of swallowing. If one firmly closes the nostrils, and performs the act of swallowing, a curious sensation of pressure is felt at the drum of each ear, there is a feeling of great fulness in the ears, and the hearing is not so sharp. If one swallows again, the nostrils being open, the sense of pressure and fulness passes away. The reason is, that by the act of swallowing the pressure of air is increased at the back of the throat, the nostrils being closed, the condensed air cannot escape that way, and rushes up the opened eustachian tubes into the cavities of the middle ear, bulging out the drums and producing the feeling of fulness and pressure. As soon as the act of swallowing is over the tubes close and the air is imprisoned. If swallowing be again performed, the nostrils not being held, the tubes are again opened and the imprisoned air escapes.

It is important to notice that there is, in healthy conditions, no communication whatever between the chamber of the middle ear and the outside except by the eustachian tube. There is no opening between this chamber and the outer passage of the ear in ordinary circumstances, for the drum completely separates the

two. But, as a result of disease or accident, an opening may be made in the drum, or the drum may be destroyed, and then of course the middle ear will communicate with the outside through the passage of the outer ear. Another important practical point is that the membrane that lines the throat is continuous up the eustachian tube with the membrane lining the middle chamber of the ear. Thus redness and swelling of the throat—a cold in the throat (see CATARRH, p. 154)—is usually accompanied by some degree of deafness, because the swelling passes up to the middle ear, and blocks the chamber.

A chain of small bones—the auditory ossicles—extends across the cavity of the middle ear, reaching from the drum in the outer wall to the oval window in the inner wall. These bones are three in number, and from their appearance were called **malleus** or hammer, **incus** or anvil, and **stapes** or stirrup. They are shown in Fig. 171, the upper part showing the stirrup bone, and the lower the bones connected. The resemblance of the third bone to a stirrup is striking. By the long downward projection (2) the hammer-bone (1, 2) is fixed to the inner surface of the drum of the ear, the projection at the side attaching it to the bony wall of the chamber in which it is lodged. The round head (1) of the hammer (3, 4) is connected with the anvil (3) by a movable joint, while the long projection of the anvil (4) is similarly connected with the stirrup-bone (5). The plate of the stirrup is fixed by membrane into the oval window of the inner wall of the chamber of the middle ear. Thus across this chamber this chain of three bones is stretched, placing the two walls of the cavity in communication. Moreover, on the inner side of the oval window is a cavity, part of the internal ear, where is lodged the essential portion of the organ of hearing. The membrane which closes the oval window, therefore, and to which is fixed the plate of the stirrup, separates the cavity of the middle ear from the internal ear.

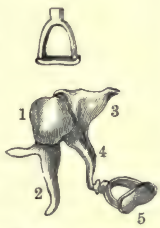


Fig. 171.—Ear-bones.

The purpose of the external and middle portions of the ear now becomes evident. Waves of sound are produced in the atmosphere about us. These waves reach us, and are directed by the appendage of the ear up the external passage, at the end of which they meet the drum. The drum is a thin membrane, and, when waves of sound beat upon it, it is thrown into vibration, reproducing, it is to be remarked, in its movements the characters of the sound-waves that have fallen upon it. But to the inner surface of the drum is attached one end of the chain of bones, and since that chain is movable, the vibrations of the drum will be passed along the chain and reach the stirrup. The stirrup fits into the oval window by means of a membrane, and the stirrup and membrane will consequently be caused to perform to-and-fro movements at the oval window, passing the movement inwards to the structures of the internal ear beyond. Thus by means of the external appendage, the external canal, the drum, and the chain of bones, the movements in the air caused by a sounding body are communicated to the internal ear.

It may be added that three small muscles are connected with the chain of bones. Two are connected with the hammer, one (the **tensor tympani**) so pulls on it as to tighten the drum to which it is attached, the other pulls in the opposite direction and relaxes the drum (the **laxator tympani**). One small muscle is attached to the stirrup (the **stapedius**) whose contraction prevents the stirrup being pushed too deeply into the oval window. The external and middle parts of the ear evidently form a *sound-conducting apparatus*. If the external passage be blocked by wax or other substances, if the drum be thickened by disease, injured or destroyed, or if the chain of bones loses its power of movement as the result of inflammation of the middle ear, partial or complete deafness of that ear is to be expected.

Having seen how sound is conducted to the internal ear, we must now see what arrangements exist in that part for receiving the sounds led to it.

The Internal Ear consists of a curiously shaped structure buried in the temporal bone (p. 19). It is represented in Fig. 172. The opening, marked 2, is that of the oval window, on the inner wall, as we have seen, of the cavity of the middle ear, and closed by the stirrup-bone and its membrane. This opening leads into a small chamber, about $\frac{1}{8}$th of an inch in diameter, called the **vestibule**. From the back part of the vestibule there open three tubes, the **semicircular canals**, so called because of their shape, which are $\frac{1}{20}$th of an inch in width and make a curve of about $\frac{1}{4}$th of an inch in diameter. One is directed horizontally (4), another upwards (3), and the third backwards (5). Opening from the vestibule by these separate open-

ings, they also join it again. The upper and back one are united at the other end and rejoin the vestibule by a common opening. Thus there are

Fig. 172—Bony Internal Ear of the right side; the upper figure magnified, the lower of the natural size.

five openings connected with the canals. Each canal has a bulging part at one end called an **ampulla,** marked thus * in the figure. From the fore part of the vestibule there passes a tube, which makes two and a half turns, coiling like a snail's shell. It is termed the **cochlea** (6, 7, 8, Fig. 172). At the base of the cochlea is the opening of the **round window** (9, Fig. 172) which communicates with the cavity of the middle ear (p. 356), but in the recent state is closed by a membrane. Besides the openings already mentioned the vestibule has several small apertures in its inner wall, by means of which there enter branches of the nerve of hearing—auditory nerve (p. 96). All these parts, vestibule, semicircular canals, and cochlea, are formed of bones, and to the whole structure the term **bony** or **osseus labyrinth** is applied. The inner surface is lined by membrane, and the labyrinth contains a fluid, the **perilymph.**

But this bony labyrinth forms only an outer casing for a membranous labyrinth. Fig. 173

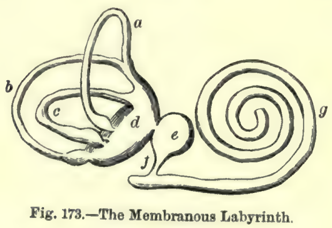


Fig. 173.—The Membranous Labyrinth.

represents the complete membranous labyrinth. It is formed of two sacs which are lodged in the bony vestibule. The larger of these sacs (*d*) is called the **utricle,** the smaller the **saccule** (*e*). These, it is to be remembered, are lodged in the bony parts described, and separated from the bony walls by the fluid—perilymph—contained in the bony labyrinth. Passing off from the utricle (*d*) are membranous semicircular canals (*a*, *b*, *c*), lying in the bony canals of the same name, surrounded by the perilymph. The inner surface of the utricle and membranous canals is lined by epithelial cells (p. 16), and from the surface fine hairs project into the interior, which contains a fluid—the **endolymph.** Branches of the nerve of hearing pass to the sac and canals, and are supposed to be in connection with the hair-like processes. The nerves are specially distributed to the sac and the bulgings of the membranous tubes. Now if these hair-like processes are connected with nerve-fibres, the slightest agitation of the fluid in the membranous canals will disturb the hairs and consequently affect the fibres of the nerve of hearing. Within the sac of the utricle are found minute crystals of carbonate of lime—**otoliths**—which may be supposed, on disturbance of the fluid, to affect more strongly the hair-like projections from the walls.

The smaller sac, the saccule (*e*), lodged also in the bony vestibule, communicates by a fine canal (*f*) with the membranous canal (*g*) contained in the shell-like cochlea, and called the **canal of the cochlea.** Further, it is found that the two sacs communicate with one another by a very fine tube, so that the whole membranous labyrinth is connected together.

The **membranous canal of the cochlea** (*g*) is the most important part of the internal ear, since in it is lodged the apparatus that is believed to be the chief agent in the perception of sound. It has already been mentioned that the cochlea possesses an outer bony case, resembling in appearance the shell of a snail (6, 7, 8 of Fig. 172). But we must now describe this bony part rather more particularly. If the cochlea be opened into, there is seen to be a central bony pillar, round which the bony tube is wound two and a half times. The central bony pillar is called the **modiolus.** The bony tube is not regular inside. From that part of it which lies against the central column, as it winds round, there projects inwards a bony ridge — the **lamina spiralis.** At the base of the bony cochlea, just where it begins to wind round the modiolus, this ridge projects well into the space of the bony canal, dividing it almost into two compartments; but as the bony canal winds round the column, the lamina spiralis, which, of course, follows the turnings, becomes less and less projecting, till at the blind end of the bony

cochlea it is not nearly so prominent. Fig. 174 shows the cochlea with part of the wall removed to show the interior. From E straight

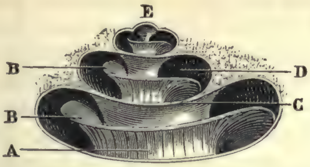


Fig. 174.—The Cochlea opened up (magnified).

downwards is the direction of the central column—modiolus—to which D points: B B point to the projecting ridge—lamina spiralis—almost dividing the canal of the tube into an upper compartment C and a lower A. (Refer also to Fig. 175.) Now in the recent state this partial division of the tube is completed by membranes, so arranged as to form a membranous canal within the bony one—the **membranous canal of the cochlea.** This will be understood from Fig. 175. This represents the cochlea cut straight down from top to bottom. M is the central column: A, B, C, and D are complete sections of the bony cochlea, in different parts of its winding, cut across. In each

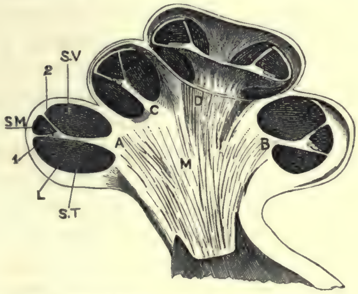


Fig. 175.—Vertical Section of the Cochlea of a Fœtal Calf.

cross section L points to the lamina spiralis, projecting inwards from the central column. From the edge of this ridge two lines (1 and 2) are seen passing outwards, and diverging as they pass, to the outer wall of the bony canal. These are membranes; the lower (1) is called the **basilar membrane,** the upper (2) is the **membrane of Reissner.** These two membranes thus complete the division between the upper and lower part of the bony tube. The upper division (S.V.) is termed the **scala vestibuli** (the staircase of the vestibule), the lower (S.T.) is the **scala tympani** (the staircase of the tympanum). Inasmuch, however, as the two membranes separate from one another as they pass across, they inclose between them a triangular space. It is this space (S.M.), formed by the basilar and Reissner's membranes and the part of the bony wall between them, that constitutes the membranous canal of the cochlea, or the **scala media** (middle staircase) of the cochlea. This part of the bony wall is, like the rest of it, lined by a membrane. Thus we have the bony cochlea throughout its two and a half turns divided into three compartments; and within the bony canal of the cochlea we have a membranous canal, occupying only a small part of the space. Now at the base of the cochlea, that is, at the beginning of the first turn, the scala of the vestibule opens into the bony vestibule already described, while at the foot of the scala of the tympanum is the round window, closed and separated from the cavity of the middle ear by a membrane. As we have seen, the vestibule has an opening in its wall—the oval window—on the outer side of which is the cavity of the middle ear, but which is closed in the bony state by the stirrup-bone and its membrane. At the top of the cochlea the scala vestibuli and the scala tympani communicate with one another by a small opening called the **helicotrema.**

Suppose, then, we begin with the external canal of the ear. Passing up it for an inch and a quarter we reach the drum. On the inner side of the drum is the cavity of the middle ear, across which stretches the chain of small bones, one end of which is attached to the inner surface of the drum, and the other end of which—the stirrup—is inserted into the oval window. On the inner side of the oval window is the bony chamber of the vestibule, opening from which is the scala vestibuli. Entering this staircase we pass round two turns and a half to the top of the cochlea. Part of the floor of this scala is the membrane of Reissner, which is also the roof of the scala media. Reaching the top we pass through the small opening of the helicotrema, and enter the scala tympani. down which we pass two turns and a half. Part of the roof of this staircase is the basilar membrane or floor of the scala media, which is thus inclosed between the two staircases. Arrived at the foot of the scala tympani we reach the round window, closed by a membrane, on the outer side of which is the cavity of the middle ear.

Next it is to be observed that the scala vestibuli and scala tympani are both filled with a fluid—perilymph. Consequently waves of sound in the atmosphere pass up the external passage and throw the drum of the ear into vibration.

These movements are conducted across the chain of bones to the oval window, and cause the stirrup-bone to make to-and-fro movements at the window. These throw the fluid in the vestibule into vibrations, which pass up the one staircase and down the other and are spent at the round window. As these waves pass along the fluid they communicate movement to the membrane of Reissner, the floor of the vestibule staircase, and to the basilar membrane, the roof of the tympanic staircase. These membranes are respectively the roof and floor of the middle scala or membranous canal, and this canal also is filled with fluid—endolymph—which is consequently agitated. Consequently the vibrations of a sounding body ultimately communicate movement to the fluid contained in the membranous canal or middle staircase.

The membranous canal of the cochlea then lies in the bony cochlea, inclosed between the two staircases, but it does not open into either. At the top of the cochlea it ends blindly. Its base lies in the bony vestibule, but does not open into it. By a small canal (*f*, Fig. 173), however, it has connection with the saccule.

Within this membranous canal and resting on the basilar membrane is a remarkable structure, first described by the Marquis Corti, and hence called **Corti's organ.** It is a very complicated structure, which it is needless to try to describe here. It consists mainly of a series of fibres—**fibres of Corti**—each made of two parts resting against one another so as to form an arch. These arches are placed, side by side, in a continuous series along the whole length of the basilar membrane. In the human ear it has been estimated that there are no less than 3000 of such arches. When viewed from above downwards by a microscope, they present the appearance of the key-board of a piano. Fig. 176 A

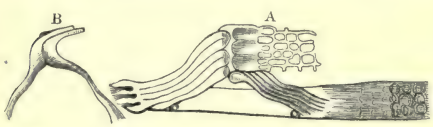


Fig. 176.—Arches of Corti's Organ (very highly magnified).

shows a few of the arches side by side, B of the figure exhibiting two fibres forming an arch. It would appear that the arches are supporting structures. For, resting on them, are numbers of conical epithelial cells (p. 16), from the free surface of which bundles of stiff hairs project. It is believed that these hair cells are the true sound-perceiving structures.

We have seen how vibrations of a sounding body reach, in the end, the membranous canal of the cochlea, containing Corti's organ. The fluid contained in this canal will be thrown into vibrations, and these in turn will affect the hairs of the cells supported on Corti's rods. These hair cells are in communication with nerve-fibres, which pass into Corti's organ through channels in the modiolus, or bony pillar round which the cochlea is wound. Thus the vibrations communicated to the hairs will affect the nerve-fibres, and cause messages to be sent along the nerves to the brain, resulting in sensations of sound.

The Sense of Hearing.

The Perception of Sound. The description that has been given of the very complicated structure of the ear will enable one to perceive how sounds are conveyed into the depths of the ear, but it is extremely difficult to understand how that apparatus enables us to have knowledge of all the multitude of various sounds of which we are daily conscious.

We must go back again to the physical world to get light on the difficulty. It is a well-known fact that if one takes two tuning-forks, such as are used for experiment in a natural philosophy laboratory, both tuned to sound exactly the same note, and if the forks are placed at some distance from one another, and one of them is made to sound, the other not being touched, in an instant both will be heard sounding. The sound of the one fork has set the other agoing. This, it must be noticed, happens only if both utter a note of the same pitch. If the two forks sound different notes, the one may be set humming loudly and long, the other remains dumb. But if the two are tuned to the same note the one is no sooner set sounding than the other is heard humming also. This is called **sympathetic vibration,** but there is no mystery about the occurrence. The one fork produces waves exactly similar to those the other would produce. When, therefore, one is sounded, the waves pass out and reach the other fork, against which they strike. Wave after wave hitting on the fork, each wave exactly suiting the swing the fork makes when in motion, gradually sets it into vibration. It is just like a small boy setting in motion a swing on which a heavy boy is sitting. If he tried to make it give a big swing with one push, he might push with all his might and accomplish nothing. If he be a wise small boy, however, he does not attempt this. He gives the swing an ordinary push, and it swings

slightly. He waits till it has moved forward, then backwards, and just as it is about to sway forwards again, he gives it another push, which, added to its own impulse, increases its movement. So he goes on till, in a short time, he has it in full swing. But if he does not time his pushes properly he will speedily stop the swing. It is the same with the tuning-fork. Each wave from its neighbour reaches it at the proper time and speedily sets it in full vibration. If now the second fork have one limb loaded, say with a piece of wax, the note of the fork is flattened. It is no longer in tune with the first one, and can no longer be set in sympathetic vibration with it, because its swing is no longer in time with the waves of its neighbour. One fork, therefore, can be set in vibration only by another sounding exactly the same note; and the fork will recognize its own note and hum in harmony with it, though the sound reach it from a considerable distance.

Suppose, then, that, on a table at one end of a room, one had a set of tuning-forks, each tuned to a particular note. Let a number of musicians proceed to play on their instruments at the other end of the room. No matter how complex the body of sound they produce, each tuning-fork will pick out infallibly its own note from the mass of sound, if its own note happens to have been produced; and if the players suddenly cease the tuning-forks will be heard sounding. By finding which of them are vibrating, one can tell what notes were produced by the players. Suppose one could have a set of tuning-forks, so numerous that there was one for every note that could be sounded, it is evident one would have here an apparatus for analysing the complex sound, that is, splitting it up into its elements. One may try a simple experiment of this kind with a piano. Let the damping pedal be lifted from the wires, and let someone sing loudly in the room, and then suddenly stop. Some of the pianoforte wires will be heard sounding. They have picked out of the song their own notes, and have been set in sympathetic vibration by them.

Now it is believed that it is somewhat after this fashion that the internal ear perceives sound. It has been noted (p. 360) that, in the internal ear, the organ of Corti contains a large number of cells with hairs projecting from them. It is supposed that each hair is sensitive to a particular vibration. The vibrations of a sounding body are conducted to the internal ear in the manner already described, and agitate the fluid in the membranous canal of the cochlea. The waves produced will be complex waves, compounded that is of simple waves of different lengths, &c. Each hair, however, will vibrate in harmony with one particular simple wave, and if that one be contained in the complex one, it will pick it out and vibrate to it. Thus the complex wave of sound will be split up into simpler forms, each hair selecting and vibrating to its own, and a multitude of hairs will be set simultaneously vibrating by the mass of sound. The ear is thus an organ that analyses (splits up) sounds into their elements.

In support of this view it may be mentioned that hairs on the feelers of the Mysis, an animal belonging to the same general class as crabs and lobsters, have been seen to vibrate in harmony with particular notes and with these notes only.

Each hair cell is in communication with a nerve-fibre, and the vibration of each hair will thus cause an impression to be passed along a nerve. The various impressions will be passed along to the hearing centre in the brain, where they become fused, and the person is conscious of a sound of a particular kind. While the ear splits up complex sounds, and communicates to the brain the elements of which they consist, the brain reunites them. We are not conscious of the splitting up process but only of the union.

The Range of the Ear for musical sounds has been determined to be from 32 to about 30,000 vibrations per second. That is to say, 32 vibrations per second produce the sensation of a low musical note, the lowest the human ear can appreciate, while vibrations occurring at the rate of about 30,000 per second produce the sensation of a very high pitch, the highest the human ear can appreciate. Vibrations more rapid cannot be taken knowledge of by the ear.

The Sensation of Discord in music is due to the interference of two sounds which are nearly of the same pitch. As two waves in water may abolish one another if the crest of one meets the hollow of another, and may again add to one another's size by the two crests meeting, so two waves of sound differing slightly from one another may at one moment almost extinguish the sound by interference and at the next produce increased loudness of the sound by being added to one another. The result is the production of what in music is called **beats**, characterized by a rising and falling of the sound. The effect on the ear is similar to the effect of a flickering light on the eye. When

the beats occur with sufficient rapidity they give a sensation of roughness to the sound, greatest when they number 33 in a second. When they reach the number of 132 in a second they are no longer perceived. Two notes that when sounded together produce beats are recognized as discordant notes.

Judgments of the direction of sound are not actually performed by the ear; they are the result of various other circumstances. Anyone can prove this by shutting the eyes and trying to decide the direction from which a sound is coming. The distance from which a sound proceeds we judge of by its loudness or faintness. It is such facts as these that the ventriloquist takes advantage of to deceive people. He imitates the character of sound from a distance, or from some particular place, by giving it the required degree of loudness, and by directing the attention of the person to that quarter, &c., his own face at the same time giving no sign of movement.

"Educating the ear" is a phrase which derives force by all that is known about the mode of action of the organ of hearing. We have seen that the ear actually analyses or splits up sounds into their simple elements, and that the brain fuses the elements together again. The habit is to pay attention only to the fused sensation. But we all know that the trained musician detects the elements of a complex sound, while the person who has given no attention to his sensations knows only, perhaps, that the sound is pleasant or the reverse. Just as surely as every ear performs the same process of analysis, so may every person, by careful training, become able to perceive something of the analysis, and to detect some of the varied elements of musical sounds that he listens to. The difference, indeed, between a "good ear" and a "bad ear" is to a large extent the difference between careful training and bad training, or no training at all. Something, of course, must be admitted to natural aptitude; but the excuse many people offer for their ignorance of music, that they have "no ear," is no excuse at all, in view of the facts that have been stated—is, indeed, but another way of implying carelessness and neglect. Just as the man, who is not blind, would be laughed at if he offered, as an excuse for being unable to read, that he had no eye, so ought a person, who is not deaf, to be laughed at if he offers, as an excuse for being unable to distinguish one note from another, or different notes in a chord, that he has no ear.

Section XII.—THE SENSES AND SENSE-ORGANS.

B.—THEIR DISEASES AND INJURIES.

Affections of the Sense of Touch.

Loss of Sensibility of the Skin (Anœsthesia);
Increased Sensibility (Hyperœsthesia);
Perverted Sensibility.

Affections of the Sense of Taste.

Excessive or Perverted Sensitiveness of Taste;
Loss of Taste.

Diseases and Injuries of the Nose and Affections of the Sense of Smell.

Diseases of the Nose:

Cold in the Head;
Chronic Discharge from the Nostrils;
Stink-Nose (Ozaena);
Ulceration in the Cavity of the Nostrils;
Tumours of the Nose;
Foreign Bodies in the Nostrils;
Bleeding from the Nostrils (Epistaxis);
Injury to the Nose;
Sneezing.

Affections of the Sense of Smell.

Loss of the Sense of Smell (Anosmia);
Over-acuteness of the Sense of Smell.

Diseases and Injuries of the Eye and Affections of the Sense of Sight.

Diseases of the Eyelids:

Skin Affections of the Eyelids;
Inflammation round the Eyelashes (Blepharitis);
Turning outwards or inwards of the Eyelids (Ectropion and Entropion);
Stye (Hordeolum);
Tumour of the Eyelid (Chalazion);
Inflammation of the Inner Surface of the Eyelids (Cold-in-the-Eye—Conjunctivitis);
Pustules (Phlyctenæ);
Thickening of the Lining of the Lids (Granular Lids—Egyptian Ophthalmia—Trachoma);
Burns—Symblepharon and *Anchyloblepharon,* or unnatural union of the lids to the eyeball and to one another;
Foreign Bodies within the Eyelids;
Drooping of the Eyelids (Ptosis);
Inability to shut the Eyelids;
Twitching of the Eyelids;
Bruises and Wounds of the Eyelids.

Diseases of the Tear Apparatus:

Obstruction of the Tear Passage.

Diseases of the Eyeball:

Inflammation of the Cornea (Keratitis);
Abscess and Ulcer of the Cornea;
White Spots on the Cornea (Opacities)—The operation for artificial pupil (*iridectomy*);
Staphyloma;
Foreign Bodies in the Cornea;
Wounds of the Cornea;
Inflammation of the White (Sclerotic) of the Eye;
Inflammation of the Iris (Iritis);
Cataract—The operation for its cure;
Diseases of the Retina, Choroid Coat, and Optic Nerve (Retinitis—Choroiditis—Optic Neuritis);
Separation of the Retina (Dropsy of the Retina);
Glaucoma;
Examination of the Eye by the Ophthalmoscope;
Foreign Bodies within the Eyeball—Sympathetic Inflammation;
Rolling Eyeballs (Nystagmus);
Squint (Cross-eyes—Strabismus).

Affections of the Sense of Sight:

Short-sight (Myopia) and Long-sight (Hypermetropia)—Treatment by Spectacles;
Weak-sight (Asthenopia); Defective Sight from Age (Presbyopia);
Astigmatism;
Blindness (Amaurosis and Amblyopia); Partial Blindness of One Eye (Hemiopia);
Night-blindness (Hemeralopia)—Snow-blindness and Moon-blindness;
Colour-blindness (Daltonism);
Double Vision.

The Care of the Eyes.

Diseases and Injuries of the Ear and Affections of the Sense of Hearing.

Diseases and Injuries of the Ear:

Diseases of the Auricle;
Inflammation of the Canal of the Ear—Boils in the Canal;
Wax in the Ear to Excess—Syringing the ears;
Growth in the Canal of the Ear (Polypus); Foreign Bodies in the Ear;
Inflammation of the Drum;
Injury to the Drum—Bursting of the drum by blows, diving, &c.;
Inflammation of the Middle Ear;
Earache;
Discharge from the Ears (Running Ears).

Affections of the Sense of Hearing:

Deafness;
Noises in the Ears.

Deaf-Mutism.

Care of the Ears.

AFFECTIONS OF THE SENSE OF TOUCH.

There are two main diseased conditions of the sense of touch, one in which the sense is abolished, which is called **anæsthesia** (Greek *a* not, *aisthanomai*, to feel), and the second in which the sense is unnaturally acute, called **hyperæsthesia** (Greek *huper*, in excess). The sense may also be perverted.

Loss of Sensibility of the Skin (*Anæsthesia*) may be due to disease of the nerves of sensation supplying the skin, or to disease of the nerve-centres, namely, the brain or spinal cord. Thus pressure of a tumour on a nerve, injury to a nerve, may produce it, while it is often produced in apoplexy and other brain diseases.

Sometimes the action of irritating substances on the skin will produce a numbness, though not exactly a total loss of sensation.

One remarkable form of loss of sensibility occurs in hysteria. In it the sense of touch, including sensations of contact, of heat and cold, and of pain, is lost on the whole of one side of the body, so that pins may be thrust into the body on one side without producing any evidence of feeling on the part of the patient. As soon as the middle line of the body is crossed, however, the sensibility is found perfect. Indeed the dividing line between the sensitive and not sensitive portions of the body is remarkably sharp. This affection is called **hemianæsthesia**, from its being limited to one half of the body.

The recognition of the cause of this disease and its appropriate treatment are subjects of considerable difficulty. The disease is essentially a nervous one.

Increased Sensibility (*Hyperæsthesia*) may be to touch proper or to pain. In some cases it is so marked that the slightest touch produces a feeling of intense pain. It occurs in connection with neuralgia, hysteria, and gunshot injuries of nerves. The increased sensitiveness may be to heat or cold.

Perverted Sensibility may be shown by contact with hot or cold objects being felt not as sensations of heat or cold but of pain. There may be feelings of burning or tingling in the skin, feelings as of the creeping of insects over the body, &c. This also is a nervous disorder. It is called **paræsthesia.**

AFFECTIONS OF THE SENSE OF TASTE.

Excessive or Perverted Sensitiveness of taste may occur. An extremely small quantity of some substance may give rise to an intense impression on the taste sense, or a very prolonged impression, or quite a different impression may be made from what is natural. Such cases are met with in the hysterical and insane. Further, tastes may be felt quite apart from any substance taken into the mouth, as a result of irritation of the nerves of taste, by disease for example. Certain substances present in the blood will cause a taste to be felt. The taste of some substances may be felt when they have been injected under the skin and not taken into the mouth at all. Everyone also knows how disordered conditions of stomach and bowels give rise to bad tastes in the mouth.

Loss of Taste occurs in hysteria and nerve affections. Thus it may result from rheumatic inflammation of certain nerves that supply the mouth and face. It may be associated with paralysis of the face, and may be lost only on one side of the tongue. Since the tongue is supplied by two nerves, so far as taste is concerned, one supplying the front part and another the back part (see p. 337), the sensibility of one part may be lost and that of the other retained. Loss of taste may also arise from no affection of nerves, but from thickening of the surface of the tongue or mouth rendering the ends of the nerve-fibres less easily affected by the tasty substance.

Affections of the tongue have been considered on p. 150.

DISEASES AND INJURIES OF THE NOSE AND AFFECTIONS OF THE SENSE OF SMELL.

Diseases and Injuries of the Nose.

Cold in the Head or nasal catarrh, which usually begins by attacks of sneezing and then goes on to a free discharge from the nostrils, has been sufficiently described under CATARRH (p. 154).

Chronic discharge from the nostrils is frequently the result of chronic catarrh, that is, of repeated attacks of cold in the head. As a result the person is annoyed by a thick discharge or by swelling of the lining membrane, causing "stopped nose," thickness of speech,

defective smell, &c. A chronic discharge from the nostrils is a feature of glanders, a disease of the horse communicable to man. It is mentioned under FEVERS.

Treatment consists in using as a snuff a powder of bismuth and alum or chlorate of potash, diluted with five or six parts of powdered starch or gum-arabic. A lotion may be used made of borax, alum, and tannin, or chlorate of potash, in the strength of 10 grains to half an ounce of water and half an ounce of glycerine. Some of this should be thrown into the nostrils by means of a syringe, consisting of a small elastic ball with a short glass nose-piece.

Stink-Nose (*Ozæna*) is the term applied to the condition in which the discharge from the nostrils is very offensive. It often depends on ulceration of the nostrils high up, and may be attended by a sense of weight or fulness high up. It may begin with some foreign body which has passed up the nostrils and lodged, setting up inflammation and ulceration by its continued presence, and ultimately leading to disease of bone. Every case of stink-nose in children should be carefully examined for some foreign body, which the child may have pushed up the nostrils. After bleeding of the nose a large clot of blood may be retained and cause, in time, an offensive discharge. Various diseases may also be the cause of ozæna—syphilis, for instance.

Treatment. — First of all care should be taken that the cause of the mischief is not a foreign body. This is necessary specially in the case of children. The nostrils should be regularly cleansed by syringing. One very efficient method may be described, which only needs a little practice. A vessel is got capable of acting as a cistern, a tin can fitted near the bottom with a stop-cock would do admirably. It is filled with water and fixed on a shelf a little above the person's head. An india-rubber tube fits on to the stop-cock and passes downwards, ending in a nozzle, capable of filling the nostril. The person stands with his head slightly bent over a basin. The nozzle is inserted into one nostril (*the healthy one*), the other being left free. The patient keeps his mouth open, breathing through it, and not permitting himself to perform the act of swallowing. If now the water be turned on it passes through one nostril to the back of the throat, passes out by the opening at the back (see p. 338), does not go down into the throat but enters the back opening of the other nostril and washes through it coming out at the front, where it is caught by the basin. By this method, *provided the patient breathes through his open mouth and does not swallow,* both nostrils can be washed thoroughly. If the person cannot get used to this method he may employ any small syringe.

Along with the washing out, by whatever method accomplished, lotions of various kinds may be used. One or two teaspoonfuls of solution of chlorinated soda to a pint of water is useful in very offensive cases, or a weak solution of Condy's fluid, water made just pink with it, or solution of carbolic acid one ounce to 60 or 80 of water—3 or 4 pints. A useful paint for injecting by a syringe, is glycerine with iodine, one grain of iodine dissolved in one ounce of glycerine.

Besides such local treatment the patient will often be benefited by taking cod-liver oil, quinine wine, tonics, &c.

Ulceration in the cavity of the nostrils will be attended by offensive discharge and is to be treated as "Stink-Nose." If the ulcer can be reached by the finger an ointment of one part of iodoform and four of vaseline should be applied. Long-continued ulceration sometimes eats through the division between the nostrils, destroying bone and gristle. This is usually the result of syphilis.

Tumours of the nose. The commonest tumour in the nostrils is what is termed **polypus**, a growth from the lining membrane, of varying size, hanging as it were from a stalk.

Symptoms. A polypus usually blocks the nostrils, so that the person has to breathe through the mouth, which is constantly kept open. The voice is generally altered and acquires a nasal twang. The finger may detect the growths, which feel like a bunch of earth-worms.

Treatment.—The best treatment is removal by a surgeon if the swelling can be reached. Washing the nostrils by means of a syringe with water containing a small quantity of salt or bicarbonate of soda (30 grains to the pint) relieves.

Warts may occur in the nose, they usually occur just within the nostril. They should be touched with glacial acetic acid, as advised for warts on p. 322. **Cancerous** and other tumours may also be present in the nostrils.

Foreign bodies in the nostrils are not uncommon in children. Cherry-stones, peas, and

even nails are often pushed into the nostrils by them. Sometimes the child says nothing about it, till after a longer or shorter time the presence of the foreign body has set up irritation, and produced discharge, which is usually offensive. Delay always renders the removal more difficult, since the substance becomes surrounded by secretion and is firmly lodged. Persistent discharge should always lead to an examination for a foreign body.

Treatment.—Let the free nostril be closed and cause the person to blow through the blocked nostril as strongly as possible. If this fails, as it often will, if the substance has been in the nostril some time, a stream of water may be employed. The nostril may be syringed from the front. If the person is old enough the method of washing out the nostrils described on p. 365 may be used, the tube being inserted into the *sound* nostril, so that the water flows on the blocked side from behind forwards. Instruments should not be used except by a surgeon. If the aid of a hairpin is likely to extract the foreign body, it may be used, *but always the looped end;* the sharp point should always be avoided.

Bleeding from the nostrils (*Epistaxis*), occurring without any apparent cause, is rather common among young people. In girls it may be a source of relief at the monthly periods. Besides such cases it may attend the onset of typhoid fever, typhus, remittent, and scarlet fever; and it is a prominent feature in scurvy, purpura hæmorrhagica (p. 237), and other diseases. It may be due to diminished atmospheric pressure, and from this cause occurs to persons in ascending high mountains. The flow comes from one nostril as a rule, and rarely from both at once. It may, as everyone knows, be due to injury.

In severe cases much loss of blood may take place and fainting result, while frequent attacks may rapidly reduce a person's strength.

Treatment.—Let the nostril be firmly closed by pressure with the hand for several minutes, the head being held high. Cold, in the form of cold-water cloths, applied to the nose, neck, and forehead, are very useful, iced-cloths being still more effective. If measures like these are useless, plugging the nostril must be resorted to. This is done with pieces of lint rolled into the form of a cone and pressed in from the front. Sometimes it is necessary to plug from behind, but only a surgeon can do this.

Should attacks be common the patient ought to have tincture of steel and quinine administered for some time.

Injury to the nose. Fracture of the bridge of the nose as the result of a blow may be recognized by the alteration of shape, and by the grating feeling if a finger be gently pressed on each side of the bridge. The broken nose may often be restored to its proper position by gently moulding with the fingers. If the bones are pressed down, they may be lifted by carefully passing up the nostril something like the bone or ivory handle of a pen or pencil-holder. If necessary, some cotton-wool may then be passed up to keep the bones from falling in again. On the outside the application of strips of sticking-plaster may help to keep the parts in place. *Immediately* after the blow cold cloths are useful in keeping down bleeding and swelling; but *some time* after hot cloths freely applied reduce swelling and pain rapidly.

A **bruise** on the bridge of the nose without injury of bone is best treated by hot cloths. When swelling has disappeared the soft parts may be adjusted as well as possible by narrow strips of skin-plaster.

Sneezing may become uncontrollable so as to be actually a disease. The ordinary explanation of sneezing is that something irritates the lining membrane of the nostril, and the sneeze is designed to expel the cause of the irritation (see p. 261). Excessive sneezing occurs in hay-fever (p. 274), due, it is supposed, to the irritation set up by the pollen of certain plants. It is a common sign of the onset of cold-in-the-head. It is, however, sometimes associated with whooping-cough and asthma, gout, and hysteria. It sometimes occurs connected with disturbance of sexual functions in women and connected with pregnancy.

Treatment.—The effect of strong smelling-salts may be tried. If so severe a measure is necessary, a mustard blister to the nape of the neck is useful. Where they seem to be indicated, quinine and iron tonics should be administered.

Affections of the Sense of Smell.

Loss of the Sense of Smell (*Anosmia*) may be due to unusual conditions of the lining membrane of the nostrils, such as swelling, thickening, &c., resulting from chronic catarrh (p. 154), or the presence of growths preventing the proper entrance of air, or to altered conditions such as may be induced by constant snuff-taking. A

second class of causes includes such as affect the nerve of smell—the olfactory nerve (p. 95). A blow on the head may abolish the sense of smell by injury to the nerve. Abscesses, disease of bone, may act in the same way. While, in a third class of cases, loss of smell is caused by disease in the brain affecting the nerve-centres for smell.

The loss may be on one side only. Loss of smell will also be accompanied by loss of flavour, since flavour includes smell as well as taste (p. 337).

Treatment is directed to the cause. Cases of chronic catarrh should be treated as advised on page 364 for chronic discharge.

Over-acuteness of the sense of smell occurs in hysteria, and as a result of weakness from chronic disease. Further, sensations of smell may be experienced without any external cause. One might call them delusions of smell. Thus a constant sense of a bad odour has attended disease of the brain and other diseases also.

DISEASES AND INJURIES OF THE EYE AND AFFECTIONS OF THE SENSE OF SIGHT.

Diseases of the Eyelids.

Skin Affections of the Eyelids. Like the rest of the covering of the body the eyelids are liable to various skin affections. These are sufficiently discussed in Section XI. B. One only need be mentioned here. It consists of an eruption of blebs, filled with clear fluid at first, but later with yellow matter. They spread from the inner part of the eyebrow over the forehead and up among the hair, and also downwards over the eyelids and the side of the nose. They are accompanied by severe pain and swelling and inflammation of the eye. The lids are so swollen that the eye is closed. This is an eruption quite similar to shingles, and properly called by the same name—**herpes**. It is treated in a similar manner (p. 317).

Inflammation round the Eyelashes (*Blepharitis*). This is really an inflammation of the hair-sac from which an eyelash springs. It begins in little swellings on the edge of the lid round a hair, and rapidly spreads along the edge. Crusts form which stick to the lid, mat the hairs together, and produce a very unsightly appearance. The lids become thickened and red. Little points of matter often form. If the disease lasts long, the lashes fall out, so that the lids may be entirely deprived of lashes. Owing to the thickening the lids are turned outwards; the tears no longer readily escape into the opening of the tear passage, and the eyes are constantly overflowing. The inflammation may spread over the inner surface of the lids and reach the eyeball; and the constant irritation of the tears, discharge, &c., may also produce ulcers on the front of the ball.

Treatment, if early adopted and persevered in, will readily cure the affection in its first stages. *The crusts must be thoroughly removed* and the lids cleansed. This should be done by means of warm water. To the water bicarbonate of soda (baking soda) may be added, as much as can be lifted on a sixpence to an ordinary tea-cupful of water. When the lids are perfectly clean they should be smeared with ointment of the yellow precipitate.[1] This must be kept up till the lids are quite restored, for the inflammation very readily returns. If the inflammation is very far advanced, the lids thickened and raw looking, &c., after crusts have been thoroughly removed, the edges of the lids may be *lightly* touched all along by a stick of nitrate of silver. In such cases it is also necessary to pull out the hairs seriously affected. As this affection is apt to spread among badly-nourished children, and children not in vigorous health, good diet should be given, and exercise in the fresh air attended to. Cod-liver oil is of great benefit also.

The inflammation can apparently be conveyed to sound eyes by particles of the crusts or matter. Care must, therefore, be taken that towels, &c., used by the sufferer are not used by others, and that hands are well washed after bathing the eyes, &c.

Turning outwards or inwards of the eyelid is frequently a result of the above inflammation. The former is properly called *ectropion*, the latter *entropion*. Injuries, burns, &c., are causes, and the inward turning is frequent as a result of the general laxness of the lid in aged people. The inturned lid grievously irritates the eyeball, against which the lashes rub, and leads to serious inflammation. In the case of the out-turned lid, the inner surface looks red and fleshy from the constant irritation of the air, dust, &c.; and the eyeball being deprived of the protective covering of the lid is also open to irritation by foreign particles, &c. Both conditions can be properly remedied only by sur-

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[1] Yellow oxide of mercury (precipitated) one drachm (60 grains) to one ounce of lard or vaseline.

gical operation. The operation is not at all serious or dangerous.

Stye (*Hordeolum*) is a small boil formed on the edge of the eyelid, occupying the sac of an eyelash. Several are apt to occur one after the other, probably because a bad state of health determines them. They form little red swellings, accompanied by considerable heat and pain. When matter has formed the pain usually ceases. The stye begins usually with an itchiness, producing a tendency to rub the part.

Treatment.—At the very beginning, before the swelling has formed completely, pulling out the lash which passes through the affected part, and then touching the place with a fine point of nitrate of silver, is said to stop its further progress. When, however, it is advanced, warm poultices should be applied, and as soon as matter is formed it should be permitted to escape by opening with a sharp clean lancet. A strong needle will do if it is put in at one side of the little collection of matter, and made to open it up to the other side. A mere prick is not sufficient, since it does not afford room enough for the complete escape of the matter.

If a person is troubled with frequent styes, cod-liver oil, iron tonics, good food, &c., are means of strengthening the person to prevent them.

Tumour of the Eyelid (*Chalazion*) is formed in the depth of the lid. It is sometimes due to the blocking of the channel of one of the glands of the lid, and the gland consequently becomes filled and swollen out by its products having no outlet. The swelling is usually round, pea-like, and often very hard.

Treatment.—When the swelling is softish warm applications, and rubbing in of the yellow ointment (see foot-note on p. 367), are sometimes sufficient to clear it away. When it is hard the best thing is to have it cut out—a very simple and not a very painful proceeding.

Inflammation of the Inner Surface of the eyelids (*Cold-in-the-Eye—Conjunctivitis—Ophthalmia*). This is the common form of inflammation of the eyes resulting from cold. The delicate mucous membrane which lines the inner surface of the lids is called the conjunctiva. As stated on p. 339 it not only lines the lids, but turns up on to the eyeball, which it covers up to the edge of the transparent part in front—the cornea. Consequently, this inflammation affects not only the lids, but also the surface of the eyeball, with the exception of the cornea.

Its **cause** is usually cold; but irritating vapours, the entrance into the eye of irritating substances, will also produce it. It happens in the course of some fevers, specially scarlet fever and measles.

Symptoms. In its simplest form there is redness of the lining membrane, and if the eyelids be examined they present a red velvety appearance. The person feels smarting and heat, beginning generally at the inner corner; the eye is sensitive and watery, and there is a feeling as of sand in it. The person can scarcely keep from winking and rubbing, and believes some sand is in his eye, the removal of which will be sufficient. In more severe cases the redness is more decided; the blood-vessels are seen to be very full and distinct; the lids are swollen, and the loose tissue between the lid and the eyeball is swollen. There is discharge, of a clear sticky character, consisting of mucus, which forms a sort of film and blurs the sight. The discharge dries and forms crusts along the edge of the lids. In the morning the lids are usually glued together with it. These are the symptoms of **catarrhal conjunctivitis.** In still more advanced cases the discharge is profuse and of yellow matter (pus), and we have **purulent conjunctivitis.** The swelling is very great, sometimes so as to overlap the eyeball. This is very serious, and must be carefully attended to lest pustules and ulcers form.

Treatment.—First of all, one must look to see that there is nothing present under the eyelids keeping up irritation and so causing the redness. Incurved hairs will do this, particles of dust, and little white gritty particles that form in the substance of the membrane, are often the cause. If such causes be removed, in simple cases, a mild lotion with which to bathe the eye is sufficient. The chamomile-tea or sulphate of zinc eye-wash is best suited for this purpose (Appendix of Prescriptions—Eye-washes). Let the person give the eyes rest, and freedom from glare of gas-light, &c., for a time. The irritation of tobacco smoke should also be avoided. In the catarrhal form similar treatment is required. The person should bathe the eyes with the lotion so that it may enter the eyes and come into contact with the whole surface. A stronger wash—the bichloride of mercury wash—is sometimes required. (See Appendix.) When the smarting and swelling are considerable great relief will be experienced by taking a pad of lint or muslin, soaking it in the last-named lotion, to which hot water has been added, and binding it on the eye. The puru-

lent form is so apt to produce serious damage to the front of the eyeball, injuring the sight, that the sufferer will display wisdom by seeking at once the advice of a competent surgeon. If that is not at the time possible the treatment recommended above should be adopted and kept constantly in use, every particle of matter being removed as soon as formed. It is not sufficient simply to bathe the eyes on the outside, the lids must be opened so that the removal of matter, that would otherwise lodge, is secured.

Inflammation of the Eyes of newly-born Children is considered under DISEASES OF CHILDREN.

Pustules, the size of a pin's head or millet-seed, are often found in the eyes of ill-nourished children. Usually they are on the edge of the cornea, the transparent part of the eyeball, and look like little raised ulcers. They are called in medical language **phlyctenæ.** Sometimes they surround the edge of the cornea like beads. The lining membrane of the eyeball in their neighbourhood is deeply inflamed, and there is usually considerable pain.

Treatment consists in inserting a piece of yellow ointment (see note at p. 367) into the eye and rubbing it over the pustule by a movement of the lids. To get the ointment into the eye take it on the end of a smooth piece of wood, say the thickness of a match; gently turn out the lower lid and smear it on, then rub the lid over the eyeball. The person's general health ought also to be attended to.

Thickening of the Lining of the Lids (*Granular Lids—Egyptian Ophthalmia—Trachoma*). After prolonged inflammation of the eyelids their inner lining becomes studded by shaggy little elevations, which appear like sago grains, and make the surface very rough. The irritation maintained by the rough lids, as they move over the eyeball, encourages inflammation. The transparent cornea becomes affected, blood-vessels are formed over it, and in the end it becomes so thickened and covered with vessels that the person cannot see with the affected eye. The eye is extremely sensitive to light, and scalding tears are constantly flowing from it.

The **treatment** is of considerable difficulty. The inner surface of the lids should be scarified to destroy the elevations, and then glycerine of tannin should be dropped on the lids, which should be taken between the fingers and vigorously rubbed together. Only a surgeon can do this properly. All the patient can do is to keep the eyes clean and use one of the washes already noted.

Burns of the inner surface of the eyelids, that is of the conjunctiva, should be treated by dropping into the eye a little castor-oil in each ounce of which 2 grains of sulphate of atropia have been dissolved. When the burn is deep the danger is of the inner surface of the lid becoming attached to the surface of the eyeball in the process of healing. In this way the lid may become so attached to the eye as to cover up the ball and prevent sight, and at the same time bind the eyeball and prevent it being moved about to any extent. This condition is called **symblepharon.** Sometimes as the result of burns the margins of the two lids grow together. This is called **anchyloblepharon.**

An operation is required to remedy either condition.

Foreign Bodies within the eyelids. Everyone knows the annoyance and pain caused by getting something into the eye, which has no business there, and which is consequently called a "foreign body." Everyone should be able to look for and turn out such an intruder. First cause the person to open his eye as wide as possible, and turn his eye up as far as possible. Let a finger be placed on the outside of the lower lid to pull it slightly downwards. By this means the lower lid is turned out and the searcher can see if anything is there. If the person turns the eye to one side and another, when directed, the whole surface is readily examined. If any particle is seen it is readily removed by the corner of a soft cloth. If a camel-hair pencil is at hand it is the best to brush out any particles. Next examine the upper lid, which also must be turned out, though that is not so easily done. The person having turned his eye downwards, catch hold of the edge of the lid by the eyelashes, and pull it well downwards and forwards. Put the point of one finger on the top of the lid well under the eyebrow, and turn the lid over on to it. A little practice makes this very easy, but at first it is difficult. If the searcher cannot do this, then let him turn the lid over on the point of a pencil or on the wrong end of a match, &c. If the foreign body is on the lid remove it as already advised. Foreign bodies on the eyeball are spoken of on p. 373. In every case of prolonged irritation of the eyelids a foreign body should be looked for.

Drooping of the Eyelid (*Ptosis*) is a paralysis of the muscle that lifts the lid, which, there-

fore, hangs over the eye and prevents it seeing properly. Children are sometimes born with it. It is sometimes due to affections of the brain. In cases where children are born with the droop, a small operation may be performed for shortening the lid and preventing it overlapping the sight too much.

Inability to shut the eyelid is caused by paralysis of the nerve supplying the lids—the seventh nerve (see p. 96). It is usually accompanied by other signs of paralysis of the face (p. 120).

The **treatment** for the paralysis cannot be discussed here. When, however, the inability to close the lid threatens danger to the eye, by dust, &c., readily falling upon it, and by drying through exposure, it becomes necessary to stitch the two lids together for a part of their extent in order to afford some protection to the eyeball.

Twitching of the eyelids may be a mere peculiarity of an individual or a sign of St. Vitus' Dance (p. 125).

Bruises of Eyelids lead to a black eye. The disfigurement resulting may be partly prevented and, at least, the discoloration made to disappear more quickly by the following method. *Immediately after* receiving the injury, if possible, apply cold water cloths all over the eyelids, and keep renewing them for some time, from a quarter to half an hour. The object of this is to prevent bleeding taking place into the substance of the lids and surrounding parts from small vessels that have been burst; for it is this bleeding that produces the swelling and colour. *After an hour or two* has passed since the injury, apply warm cloths, not too warm, and keep bathing with warm water as long as one's patience will permit. Before going to bed a thick pad of flannel, wrung out of warm water, should be bound over the injured part. The warm applications should be kept up till the swelling and discoloration have disappeared. All rubbing with lotions, arnica liniments, &c., should be abstained from. They do more harm than good; and, on a part badly bruised, are apt to lead to suppuration or sloughing. The hot applications are sufficiently stimulating and promote the removal of the effused blood, &c. *The most utterly wrong thing to do* is to apply leeches or lancet. These draw fresh blood from the vessels, never remove from the part blood already poured out. They make opening for the admission of air, and are invitations to suppuration and death of the part.

Wounds of the eyelids should be treated by a surgeon, since he may so adjust gaping parts as to leave little permanent mark. This is best done in appropriate cases by stitches.

Diseases of the Tear Apparatus.

Obstruction of the Tear Passage. On page 339 the nature of the apparatus for carrying off the tears has been described. The canals in the inner portions of the lids are narrow, and the opening on the edge of the lid small. They are, therefore, very easily blocked. A swollen condition of the lining membrane is quite a sufficient cause of such a blocking; and, since the lining membrane is continuous upwards with that covering the inner surface of the eyelid and part of the eyeball, and downwards with that lining the nostrils and throat, it is liable to share in affections of these other parts. Cold-in-the-head, for this reason, readily extends up the tear passages, producing swelling and increased amount of secretion from the membrane. The obstruction very often begins, not in the canals, but in the tear-sac (p. 339), which becomes affected by the catarrhal condition (p. 154).

Symptoms. The person is troubled with "a weeping eye." The tears gather at the inner corner of the eyelids and run down over the cheek. Especially is this troublesome in cold and windy weather. The nostril of the affected side is dry. Sometimes owing to accumulation of discharge in the sac a small swelling is formed at the inner angle of the eyelids. If the person press with his finger over the swelling it may be emptied, discharge welling up through the tear passages into the eye. The discharge may be clear or mattery. But if the sac cannot be thus emptied the matter is apt to burst its way through the skin at the side of the nose, and a small opening is produced through which matter comes. This is a **fistula** of the tear-sac. *Acute* attacks of inflammation are not uncommon. The inner part of the eyelids becomes red, dry, swollen, and acutely painful, and the inflammation may extend along both lids, so that the eye becomes almost or quite closed.

Treatment is most successful if begun early. Everyone with a "weeping eye" should at once seek competent advice lest this affection be present. A probe is passed along the canal and down through the sac into the nostril. When this is carefully done it is not so painful as

would be expected. It clears the passage and restores the use of the part. But it must be done frequently till the passage is made quite clear and remains so. Hot applications are the appropriate remedy in acute cases, the probing being delayed till the acute attack has passed.

Diseases of the Eyeball.

The cornea or transparent window of the eyeball is most liable to disease, to inflammation, &c. It is plain how serious such affections may be. For, if they involve the cornea to any extent, seeing is at once interfered with, and sight may be practically lost, because this part has lost its transparence, and cannot, therefore, be seen through, while every other part of the eye may be healthy. It is, therefore, necessary that people should be able to learn for themselves whenever this part is threatened, and how, in the event of surgical advice being unobtainable, they may avert the danger.

Inflammation of the Cornea (*Keratitis*) may affect only the surface of the part and be a comparatively simple affection, or it may involve the whole thickness of the cornea and not pass off till it has rendered it untransparent and cloudy and whitish, with permanently lessened sight.

Its **symptoms** are chiefly extreme sensitiveness to light, pain, excessive production of tears, and sneezing when the eyes are opened. The person usually keeps the eye shut, because of the pain light produces. The eye is running with tears, which scald the lids and face. The pain shoots to the temple and eyebrows. Sneezing whenever one attempts to open the eye is due to the action of the cold air on the irritable eye. So tightly does the person keep the eye shut that it is difficult to get a sight of the ball. If one succeeds in seeing it, a red circle of vessels may be noticed all round the margin of the cornea; and perhaps by allowing the light to fall sideways on the cornea, one may be able to see that the surface is not so smooth as is natural but appears ruffled. The other symptoms are so characteristic that they are frequently enough, though the eye cannot readily be seen.

Treatment.—No lotion capable of irritating ought in such cases to be employed. Specially are washes of sugar of lead to be guarded against, since the lead tends to deposit in the inflamed cornea and leave scars that cannot afterwards be removed. Soothing applications only should be employed. Warm cloths applied to the eye are a great relief. A solution of atropine, 2 grains to the ounce of water, should be obtained, and a few drops dropped into the eye once a day. The eye should be closed and a pad of lint secured by a bandage placed over it. A blister the size of a shilling ought to be placed on the temple, where it is left for twenty-four hours, then removed, and the part covered with a piece of lint anointed with oil or fresh butter. The bowels of the person should be kept regular, and good food ordered. Change of air is beneficial. With such treatment recovery should occur in a week or two. It may be mentioned that an inflammation like this may be maintained by the irritation of bad teeth. The teeth should, therefore, be examined and bad stumps extracted.

In the **severer form** of the attack the central part of the cornea is seen to be roughened and cloudy, and the cloudiness spreads over the whole transparent surface, giving it a ground-glass appearance. It is very serious, since it may only pass off to leave the cornea so white that sight is seriously diminished if not lost. The cornea, which in health possesses no blood-vessels, is also liable to become invaded by vessels, which render recovery still more difficult. The inflammation may run on for weeks and months, attacking one eye after the other.

Treatment.—It is specially in children of a very weakly sort that the inflammation is so severe. At its very outset, therefore, attention should be given to the child's health. Cleanliness, good food, fresh air, and cod-liver oil are valuable aids in the treatment. The eye itself is to be treated as directed above. Drops of atropine are to be employed daily; an occasional blister is to be put on the temple; some extract of belladonna is to be made into a moderately thick paint with water or glycerine and spread with a brush over the outside of the shut eyelids, which are then covered with lint, a bandage securing all. Each day the belladonna paint put on the day before is to be bathed off, and more applied. With care this combined treatment will usually be sufficient; but use of the eye is not to be permitted till it is perfectly recovered, and till no trace of over-sensitiveness to light remains.

Abscess and Ulcer of the Cornea are usually the result of injury to the eye—a stroke from a piece of coal, for example; or they occur in persons in depressed states of health. They have the appearance of white spots in the clear

part of the eye. In the case of the ulcer, by looking carefully from the side, one may see that part of the substance of the cornea has been destroyed, and that there is a little hollow on the surface. When the abscess passes deeply into the substance it may open into the anterior chamber of the eye (p. 340), into which matter drops and in which it collects. When this has happened, if the person is made to look up, the yellow matter is seen at the lower border of the transparent part. Sometimes an abscess or ulcer spreads over a large part of the cornea, so destroying it that a large part of it breaks down and separates. In cases where an ulcer has eaten its way through the whole depth of the cornea, it is not uncommon for the coloured part of the eye—the iris—to be pushed forwards and a part of it to bulge through the opening and appear as a little roundish bleb. This is called **hernia of the iris.** When it occurs it seriously delays recovery and injures the chances of a seeing eye being left. After healing and closing of the ulcer the iris remains caught in the scar, and thus the curtain of the eye becomes attached to the transparent cornea in front. Eye surgeons call this condition **anterior synechia.**

The **symptoms** of abscess and ulcer are intense pain, redness and watering of the eye, and on opening the lids the changes going on are quite apparent.

Treatment.—Apply warm cloths. Carefully abstain from using any irritating wash whatever, such as sulphate of zinc wash or sugar of lead wash, &c. Let fall daily into the eye one or two drops of the solution of atropine (2 grains to the ounce). At night paint over the eyelids with belladonna, as directed on p. 371, and let the paint be bathed off in the morning and warm cloths again used. An occasional blister on the temple will help to relieve pain. The person ought to be well nourished, and if in weak health ought to have quinine and iron tonics, cod-liver oil, or syrup iodide of iron (from half to one teaspoonful, according to age). If matter appears inside the eye, an operation must be performed for getting rid of it. Abscesses and ulcers are, however, so serious that from the first a competent surgeon should be consulted.

White spots, opacities, on the clear part of the eyeball, are frequently left as marks of inflammation, abscess, or ulcer. Parents often notice that their children suffer from "weak eyes," as they say—that is, the eyes are red, and watery, and the child avoids the light; but they think nothing of it till they observe "a scum growing over the sight." This simply means that inflammation has been permitted to go on neglected, and the part has lost its transparency and become cloudy. In children something can sometimes be done to diminish the white cloud, but it is not often it can be made entirely to disappear. In grown-up persons these white spots cannot be removed at all. Many people are also under the delusion that the whiteness is caused by something that has "grown over the sight," and can be cut or scraped off. This is a mistake. It is no new thing added to the front of the eyeball. It is simply a part of the cornea that has become white owing to inflammation. If these opacities, as they are called, are to be avoided, it is by having each eye carefully attended to as soon as there is the least evidence of anything wrong.

Treatment.—Bathe the eye with an infusion of chamomile flowers, weakened by the addition of warm water. When the white cloud prevents sight the eye can frequently be improved by an operation for forming an **artificial pupil,** called **iridectomy,** which consists in making an opening in the cornea, passing in a fine forceps, seizing and pulling out a part of the curtain of the eye—the iris—and snipping it off with scissors. An oval opening is thus made in the iris through which light can pass. This is very successful in restoring sight when the opacity occupies the centre of the cornea, leaving a broad clear margin, and when the eye is otherwise healthy. The result of the operation is simply to make a new pupil; and of course the place which affords the most room for this is selected, provided it is in such a position as to be quite uncovered by the lids when the eye is open. Another case also very favourable for the operation is where the opacity is largely one-sided, leaving the other side clear. But when the whiteness extends over nearly the whole of the cornea, no operation is likely to do much good.

Staphyloma is the proper term applied to the condition shown in Fig. 177. As a result of inflammation the cornea becomes cloudy and weakened, and yields before the pressure within. The bulging is often so great that the eyelids cannot close over it. It is very disfiguring, and sometimes it is best to have the eyeball entirely removed. Its presence often is a source of weakness to the sound eye, and on that account its removal is still more desirable.

Foreign bodies in the cornea are very common among miners, iron-workers, and people of similar employment. *Fire in the eye* is the usual phrase they have for such things. If the foreign body is loose within the eyelids, it is to be removed in the manner described on p. 369. But frequently small particles stick in the substance of the cornea, and require removal by means of some sharp instrument. In every large work there is usually one man specially skilful in removing such bodies, but frequently the most some of them succeed in doing is to scratch the cornea in various directions and set up serious inflammation. No one should attempt to remove such a body except with the clearest light. Often when the most careful examination in the ordinary way fails to reveal anything on the eyeball, the use of a large hand lens to focus the light on to the cornea will show the speck. Specially if the person look sideways over the surface, will he see the presence of any irregularity of the surface. Eye surgeons have special lance-pointed needles, set in handles, for removing foreign bodies. The patient sits facing a window, and his head is to be firmly held by someone behind. The operator sits directly opposite the patient, and opens the eye with the forefinger and thumb of the left hand, fixing the eyeball by slight pressure with finger and thumb. *He must never scrape at random*, but cause the patient's head to turn or cause him to turn his eye, so that the light falls in such a way as distinctly to show the foreign body. The needle is now to be deliberately and carefully placed down at the side of the body, and moved so as to turn it out; and this repeated till the object is removed from its fixed position, when the lid moved over the place by the finger may finally remove it. No sudden scratches must be made, one after the other, in the hope that one of them will effect the desired purpose. If good daylight cannot be obtained the person should be set down at the side of a gas bracket, which can be moved to cast the light on the eye in the way best fitted to show the foreign body, and a hand lens used to throw a strong beam of light.

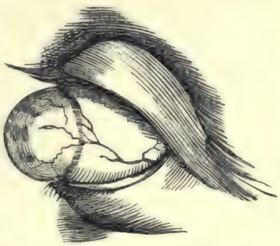


Fig. 177.—Staphyloma of Eyeball.

Wounds of the Cornea are frequent from chips of steel, pieces of coal, &c. Pieces of coal are the worst from their dirtiness. It is of the utmost consequence in such cases to know whether the chip that struck the eye has passed into the ball, or has simply cut the cornea. This is generally made out by shutting the eye and pressing gently but firmly all over the upper and lower lid. If pressure at a particular spot causes a sharp pain each time it is made, the chances are the piece that has struck the eye has passed inwards. If this is so, the eye almost surely will require removal, and that speedily, lest the sound eye becomes inflamed by sympathy (p. 376). Another danger of wounds of the cornea is that, if the cornea is completely cut through, the curtain of the eye—iris—may bulge forward into the wound. This not only delays healing, but serious inflammation may arise from the pinching of the iris in the wound. Wounds of the cornea may also lead to abscesses, ulcers, &c.

Treatment.—Till competent advice can be obtained the eye should be carefully bathed with warm water. A drop of solution of atropine (2 grains to the ounce of water) should be inserted within the lids, which must be very carefully and gently opened for the purpose. A pad of lint should then be applied over the eye, and secured by a bandage pressing just sufficiently to prevent movement of the lids. If pain is great, apply hot cloths over the pad. The atropine may be dropped in twice a day. If inflammation of the sound eye threaten, no time must be lost in seeing an eye surgeon lest both eyes be destroyed.

Inflammation of the white of the eye (the sclerotic, p. 339) appears in the form of a round red swelling, yellowish on the top. It may form a prominence of the size of a pea or small bean. It is to be treated with warm fomentations, and the eye is to be closed, a pad and bandage being applied.

Inflammation of the Iris (*Iritis*). The iris, as explained on p. 340, is the curtain of the eye, whose hue gives the colour to the eye. In its centre is the round opening or pupil. The iris regulates the amount of light admitted to the eye. By contracting it narrows the pupil to a very small opening; and this it does under the influence of much light. By dilating it widens the pupil, and this it does when light is dim, so that more may be admitted. It is, therefore, easy to test whether the iris is in a healthy con-

dition. Shade the eye from light, the pupil should widen; let the light fall full upon it, the pupil should narrow. This test may also be applied by simply shutting the lid of the person whose eye is being examined and then rapidly opening it. On the instant of opening, the pupil is seen to be wide, and it immediately contracts. In dim light a taper may be used and brought near or held close to the eye.

The chief **symptom** of inflammation is the inability of the iris to act under the influence of various degrees of light, or it acts very slowly. This is due to the curtain becoming thickened by the inflammation. Perhaps the first symptom is intense pain, worse at night, so that the sufferer gets no sleep. Light falling on the eye is painful, and the tears flow. But neither of these symptoms is so bad as in inflammation of the cornea. When the eye is carefully looked at and compared with the sound eye, it is found to have changed colour, and is of a greenish, reddish, or yellowish hue. Then the action of light should be tested as already explained. On carefully looking at the eye a circle of fine red vessels may be seen surrounding the transparent cornea.

The **causes** of this inflammation are various. Rheumatism is a very frequent one and syphilis. In inflammation resulting from syphilis it is common to see one or more red fleshy points on the border of the curtain. Cold may also induce an attack.

The **results** of the disease may be very serious. The iris may become attached to the lens behind so as to become permanently fixed. This is called **posterior synechia.** In some cases the pupil becomes altogether closed, causing loss of sight.

Treatment.—Whether one is sure of the true character of the disease or not, the first thing to be done is to let fall a few drops of the solution of atropine into the eye, and to repeat this once or twice daily. This widens the pupil so that if it becomes immovable it is fixed in the most favourable position for sight. If the case is advanced the pupil may not widen at all. This is a sure indication of the nature of the disease. Keeping the pupil wide also keeps it at rest and aids recovery. The eye should also be closed, the belladonna paint (p. 371) applied, as well as a piece of lint and a bandage.

The patient should secure a free movement of the bowels by one or two of the compound blue and colocynth pills. This may be repeated every second night for several times. In severe cases a pill containing 2 grains of blue pill and 1 grain of quinine (for grown-up persons) may be given twice or thrice daily for a week or ten days, unless the gums become sore, when they should be stopped. A blister on the temple aids the purgative medicine in relieving the pain.

When the disease has passed off it may leave a very contracted or closed pupil. After a sufficient time has elapsed—several months—an operation may be performed for the purpose of making an artificial pupil, and restoring some degree of sight by affording a passage for rays of light. The operation is called **iridectomy** (see p. 372).

Cataract is an affection of the crystalline lens (p. 340), by which it gradually ceases to be transparent and becomes more and more opaque. There is no mistaking a case of ordinary cataract. The window of the eye is quite clear, the iris has its usual appearance, but through the pupil is seen the whitish lens. It was called cataract by the ancients, from the Greek verb to flow down, because of the idea that the dimness of sight was due to some watery material flowing down behind the pupil and obscuring the sight. It is caused by some alteration in or interference with the nourishment of the lens. It is commonest in old people from the general failure due to age, a large number of cases being in persons over forty years of age, and the largest number in persons over sixty. In diabetes (p. 303), a disease profoundly affecting the nourishment of the body, it is very common. It is also caused by interference with the lens through accident. Any injury of the eye, which has affected the lens, is likely speedily to lead to cataract. Children are sometimes born with cataract. In some of these cases the opacity extends over the whole lens, in others it is confined to a small part of the lens, and appears as a white spot beyond the dark pupil.

Cataract usually, in cases of old persons, comes on slowly, so that the person feels a gradually increasing dimness of sight, which spectacles do not benefit. There is no pain, and the loss of sight never occurs suddenly. But as dimness of sight may arise from many causes, only an examination of the eye is sufficient to decide whether cataract or other disease is the cause. When the cataract is complete, that is when the entire lens is quite opaque, so that for all practical purposes the person is blind, the light from a lamp or candle can still be perceived in all directions, and the person can point to its direction if it is moved about.

Treatment.—In favourable cases, that is in

cases where there is no other disease that would interfere with sight though there were no cataract, the opaque lens can be removed by an operation, and good sight restored. Of course after the lens has been removed strong convex glasses must be used to enable the person to read. The favourable cases are known by the person being able to follow the light from a lamp moved in all directions, and to point to its direction. The operation consists in cutting round the margin of the cornea until a sufficient opening is made for the lens to pass through. An instrument is passed through the opening to tear open the capsule which holds the lens. When this has been properly done gentle pressure of the lids urges the lens out. Immediately after the operation the patient should be able to see clearly with the eye. A person desiring this operation to be performed should always place himself or herself in the hands of an eye surgeon of repute, since there are a considerable number of risks (to the eye only) that attend the operation. For example, if undue pressure be exerted on the eyeball, not the lens only but some of the vitreous humour behind it may be pressed out. If much of this escapes the sight of the eye will be lost. The operation, therefore, requires skill and delicacy. As soon as the lens has been removed the eye is closed with plaster and a bandage, and the patient is put to bed and kept lying quietly on the back in a dark room for several days. If all goes well the bandage is not undone for four or six days, and it is at least a week before the person is permitted to get up, and several weeks before he is permitted to begin gradually to accustom the eye to light.

An old operation, called **couching**, consisted in passing in a needle and with it pushing the lens out of its place to leave the pupil clear. The lens was thus left in the eye; but it was so apt to set up inflammation by its presence in an unusual position that this operation has been abandoned.

For this operation chloroform is not at all necessary. Indeed surgeons prefer not to give it if the patients are old enough to keep still.

In children the lens is soft, and cataract, when complete, is dealt with in them by passing a needle through the cornea, and through the capsule of the lens, and stirring up some of the soft lens so that it escapes into the chamber behind the cornea—the anterior chamber of the eye (p. 340). It is gradually absorbed there, and after some weeks, when all evidence of the operation has disappeared, the process is repeated with another portion of the lens. In about three months, by repeated operations, the lens disappears, and sight is restored.

Diseases of the Retina (p. 341), **Choroid Coat, and Optic Nerve** are numerous, and are the causes of serious defects of vision and of blindness. It is useless to consider them in this work, since their detection requires an oculist. Some features regarding them may be mentioned. Very serious disease may exist in the deep parts and at the back of the eye without any evident symptom. The sufferer is aware of something wrong from failing sight, which he in vain strives to benefit by spectacles. **Inflammation of the retina** (*retinitis*), **inflammation of the choroid coat** (*choroiditis*), **inflammation** (*neuritis*) **and atrophy** (*wasting*) **of the optic nerve** are the names of some of these affections. They arise from many varied causes. Exposure to cold, changes in the blood such as exist in anæmia and in syphilis, diseases of the brain, and many other causes operate in producing such affections. It is of the utmost importance to observe that excess in spirituous liquors and in tobacco not infrequently leads to failure of sight from changes in the nervous structures of the eye. For such cases total abstinence is the only treatment. In women too prolonged nursing may induce weak sight from affection of the retina and optic nerve.

Separation of the Retina (*Dropsy of the Retina*). In this disease fluid is poured out between the retina and choroid coat at the back of the eyeball (p. 341), with the result of partly separating them from one another. The retina is caused to bulge forwards, at least that part of it behind which the fluid is. Blindness more or less complete, according to the extent of the separation, results.

Treatment of various kinds has been tried with indifferent success. An operation was proposed many years ago for passing a narrow knife through the coats of the eyeball to reach the seat of the dropsy, in order that the fluid might be permitted to escape. A method practised by Dr. Wolfe of Glasgow has in proper cases been remarkably successful in restoring good sight to eyes previously practically blind.

Glaucoma is the name given to a disease which affects every part of the eyeball and ends in complete blindness. The chief feature of it is that the eyeball becomes of a stony hardness. It sometimes comes on quickly in an acute

form, sometimes it creeps on slowly. The disease occurs in old and weak persons, sometimes from exposure to cold, sometimes apparently from fright, and from other causes.

The **symptoms** of the acute attack are violent neuralgic pains in the eyeball, brow, and temple, and perhaps vomiting. Dimness of sight comes on rapidly. The patient sees rays of colour round the flame of a lamp, candle, or gaslight. The eyeball, as already mentioned, becomes very hard. In chronic cases there are only occasional attacks of neuralgic pain, and the eyeball gradually becomes of a stony hardness. In time other changes occur in the cornea, lens, &c. In advanced cases the pupil has a greenish look; hence the name *glaucoma*, which means green tumour.

The **treatment** commonly adopted is the performance of the operation of iridectomy, noted on p. 372. It was first suggested by the distinguished German oculist, Von Graefe.

The **ophthalmoscope** is the instrument by means of which the deep parts of the eye can be examined, and the condition of the nervous coat at the back ascertained. It consists of a small mirror on a handle. The mirror is slightly concave (hollowed). It is held in front of the eye of the examiner, and in its centre is a small hole through which he looks. The patient sits opposite the examiner. Behind his head and to the side is a lamp producing a bright light. The examiner catches the light on the mirror and throws it through the pupil of the eye he is looking at through the small hole in the mirror. The back of the eyeball is illuminated, just as one might illuminate a room by throwing a strong beam of light from a bull's-eye lantern through an opening in one wall. The use of the instrument requires practice; for, unless the examiner's head is in the direction of the light reflected from the eye, the pupil will appear black and he will see nothing. As soon as he catches the light coming back from the eye, he sees a red glow from the back of the eye, and by gradually bringing his eye with the mirror in front nearer, he at last reaches the position from which he sees the opposite wall of the eyeball. The optic nerve entrance, the blood-vessels passing over the retina, &c., are seen, the condition of the humours of the eye is perceived, and one familiar with the healthy appearance can make out change from disease. The instrument was devised by Professor von Helmholtz, now of Berlin. The mirror may be used alone, or with a doubly convex lens.

Foreign bodies within the Eyeball are unfortunately very common among workers in coal, iron, steel, &c. Striking with sufficient force the chip of steel, &c., pierces the coats of the eyeball and passes to the inside. The piece may lodge in the iris, from which it may sometimes be removed with the wounded part of the iris by the operation of iridectomy (p. 372). If it lodge in the lens this body speedily looses its transparency, and may be removed with the foreign body by the operation for cataract. It may lodge in the back chamber among the vitreous humour, or in other situations from which it cannot be removed. Sometimes it may be seen by means of the opthalmoscope. In many cases the person is not sure whether the foreign body that struck him passed in or simply wounded the eye in flying past. In such cases if pressing over the eyelids in one particular spot produces a sudden sharp pain, the probability is the body is within the ball. Inflammation arises, severe pain is felt, the sight grows dim, &c. The danger is of **sympathetic ophthalmia** arising. This is inflammation occurring in the sound eye through nervous communication with the injured one. It is extremely serious. If the slightest sign of it arise, the injured eye should be removed without delay, even though it be yet a seeing eye, in order to save its fellow.

Rolling Eyeballs (*Nystagmus*). This is a continuous rolling movement of the eyeballs, which are constantly shifting about. It is seen in children, the corneæ of whose eyes have lost all their transparency owing to inflammation, and perhaps is due to their seeing the light and continually endeavouring to gain clearer vision. Various other diseases of the eyes, affecting vision, produce it. Among miners cases of it arise by no means seldom. In them it appears to be induced by long-continued work underground in the dim obscurity of a flickering lamp. It gradually becomes associated with nervous disease of the eyeball. Little can be done for it. But a young lad who has already worked some years underground, and shows signs of it, should at once be persuaded to change his occupation and take to something above-ground in the ordinary light.

Squint (*Cross-Eyes — Strabismus*) has been mentioned on p. 350. It is usually due to one muscle having a greater pull than another, so that the balance between them is lost. It may, however, result from paralysis of one muscle,

by a blow, for example, the opposite muscle thereby gaining the advantage. There are several kinds of squint, the two chief being inward or convergent, and outward or divergent. It has been shown that inward squint, in a large majority of cases, is dependent on long-sightedness, and outward squint on short-sightedness. Outward squint, however, is not so common as the other variety. Of convergent or inward squint Stellwag, one of the greatest of authorities on eye affections, says it "is frequently developed at a very early age in children, whose attention is often and continually attracted to small objects situated near the eyes, to whom picture-books and similar playthings are offered for amusement, which demand clear and distinct vision at short distances. As a rule, however, inward squint first makes its appearance at the commencement period when children go to school, when children are compelled for hours to read, write, and engage in similar occupations. . . .

"Everything that increases the necessity for focussing also increases the tendency to squint. In so far insufficient illumination, dark rooms, bad care of the child during the occupation, &c., may favour an occurrence of the strabismus."

Now when squint exists, whether in one eye or both, the two eyes cease to act in harmony, and one of the chief benefits of seeing with two eyes — binocular vision (p. 350) — no longer exists. Moreover, supposing one eye only to squint, it invariably happens that the sight of that eye is largely discounted, is disregarded. Were that not so, seeing that the two eyes do not agree, objects would appear double, but by disregarding the sight of the squinting eye single vision is retained. The result of continued disregard, however, is that the squinting eye loses its sharpness of sight, its vision becomes blunted. Anyone may learn this for himself by causing a person with a squinting eye to look at an object, first with one eye and then with the other, and he will find how dulled the squinting eye has become.

The **treatment** for squint is twofold. In the first place, with children the causes leading to squinting must be done away with. They should not be required to look long at objects so small as to require much focussing of the eyes; their reading, writing, &c., should be taught in well-lighted rooms. If the child is quite young when the tendency shows itself it will be well to cease instruction of such kinds, of knitting, &c., for a time. When the child is old enough, glasses to correct the long sight should be obtained. It is also a good thing, when there is but one squinting eye, to have the sound eye closed up by means of a bandage for fifteen minutes several times each day, in order to compel the use of the erring one. Of course such procedure is useless unless the other steps already described have been taken. Should these measures fail an eye surgeon would probably propose an operation. It consists in cutting the muscle of the side to which the eye is pulled. It is a simple operation, not requiring chloroform in grown-up persons. It is desirable to do it early, if it is certain other measures fail, before the eye has been blunted from disuse. The muscle is, by the operation, detached from its position. It slips backwards for a little distance, and in course of time attaches itself to a new part of the eyeball. In effect the muscle is lengthened, so that it no longer has the pull over its fellow on the opposite side. Even when this has been done, providing spectacles to correct any long or short sight that may be present ought not to be neglected. In grown-up persons its main benefit is the correction of an unpleasant feature. To girls this is always of moment.

Affections of the Sense of Sight.

Short-sight (*Myopia*) and **Long-sight** (*Hypermetropia*) have been explained on pp. 346 and 347. For the former the treatment is doubly concave spectacles, for the latter doubly convex spectacles, which any optician can supply. Care should be taken *never to get concave spectacles too strong*, else the short-sighted eye is converted into a long-sighted one. Persons cannot suffer from any degree of short-sight without being aware of it. They cannot recognize a friend at any distance nor read a sign over a shop door on the opposite side of the street from them. But long-sighted persons see well at a distance. If they are only slightly long-sighted it is only when they come to look at near objects that the defect occurs. But when the error is slight, persons may not be aware of the long-sight, so effectually does the focussing serve their purpose. But they are continually focussing to see objects which ordinary eyes perceive without any alteration of the lens; thus their apparatus for accommodation of the eye (p. 345) is continually in use and becomes strained. The person may go on for years unaware of this. By and by, however, the person begins to feel an undue strain on his eyes with reading, writing, drawing, &c. His

eyes ache with any prolonged use. They look red and watery after work. After reading for a time the letters run together. He shuts his eyes for a moment, and then on opening them he can read a little time longer, till the letters again run together, and so on. It is easily seen, therefore, how giving a short-sighted person too strong glasses, and converting him by them into a long-sighted individual, makes matters worse.

A short-sighted person is likely to improve as age advances. The lens becomes flattened, does not converge the rays of light so strongly, and therefore the degree of short-sight diminishes. As years pass weaker glasses often suffice.

Weak Sight (*Asthenopia*) is as often due to a slight degree of long-sight as to anything else, and the remedy for this should be tried.

Defective Sight from Age (*Presbyopia*—Greek *presbus*, an old man). With advancing years the lens loses its elasticity, and consequently its degree of convexity undergoes less change than in youth. It also becomes flatter. Near objects are not so readily focussed. As age grows, persons find themselves less and less able to read and do fine work with the unaided eye. Happily convex spectacles readily restore the former distinctness of vision, if nothing else is at fault with the eye.

Astigmatism is a curious defect of the eye, first observed by Thomas Young. It is due to the cornea having different degrees of curvature in different directions. Usually the vertical meridian is more curved than the horizontal. The result is that rays of light passing through the vertical meridian will come to a focus sooner than rays passing through the horizontal meridian. Consequently, all the rays from an object are not brought to the same focus, and the object appears blurred. All eyes have this defect to a slight extent, to such a slight extent that it is not noticed. But let anyone draw a perpendicular line on a black board with chalk, let this line be crossed by another at right angles, and let the person, standing at a distance, look at the point where the two lines cut one another. Looking at this point steadily he will find that he sees both lines, but one more distinctly than the other, showing both are not focussed at the same time. Of course one usually moves the eyes rapidly over objects looked at, and forms the idea of them from successive glances, without being aware that the whole object is not distinctly perceived at one glance. It is only when the defect is excessive that persons become aware of it. The error is corrected by the use of glasses ground from a cylinder; ordinary glasses are ground from a sphere. Such spectacles are plane in one direction and concave or convex in the other. The glass is so placed that the direction of the curve is placed over the meridian of the eye requiring correction, and the degree of the curve is so arranged that by its means the cornea is made practically equally convex in all directions. Short-sight or long-sight is often associated with astigmatism, so that special spectacles require to be made which shall correct the long or short sight and the astigmatism as well. It is often a matter of very considerable difficulty to determine the degree of the defect, and the decision as to the sort of glasses required is often a very tedious process. Astigmatism is very commonly inherited.

Blindness may be due to many causes, loss of transparency of the cornea (p. 372) or lens (p. 374) preventing the entrance of light, diseases of the choroid, retina, or optic nerve (p. 375), affections of the brain, &c.

Amaurosis and Amblyopia are old words, used to express, the former total blindness, and the latter dimness of sight. They were used before the causes of such conditions could be ascertained; but as these conditions are now referred to affections of retina, optic nerve, &c., the old names are being dropped.

Partial Blindness (*Hemiopia*) of an eye, with which nothing seems wrong, may occur. The person, looking straight at some one standing in front of him, sees only one half of him. Half of the retina is blind. This may begin in one eye, but extend to both, the vision of a corresponding half of each retina being lost. It is due to disease of the optic nerve roots. Syphilis is frequently the cause.

Night-blindness (*Hemeralopia*) is the result of a blunting of the sensitiveness of the retina owing to some excessive irritation. It has its origin in the long-continued action of strong light upon the eye, and is also connected with weakness of the nervous system. The retina may be blunted by the strong glare from snow; and this may occur to those who walk over fields of snow or ice among the mountains, without having the eyes protected by a dark veil or dark glasses. This is called **snow-blindness**. Similarly, **moon-blindness** is a like condition, produced among sailors in the tropics who sleep on deck under the full light of the moon.

Colour-blindness (*Daltonism*). This affection was called *daltonism* because it was first described by John Dalton in 1794. Colour-blindness, however, exists in several forms. The form to which the term "daltonism" is properly applied is a lack of sensibility to red. Red light and red objects appear greenish or greyish. Since, according to the theory explained on p. 351, the sensation of colour is a mixed sensation, dependent upon the excitement of three sets of nerve fibres, one set sensitive to red, another to green, and a third to violet, an excitement of all three in a definite proportion producing the sensation of white, and in various other proportions, the sensations of the other colours,—since this is so, the loss of sensibility to red will affect not only the perception of red but all other perceptions in which the sensibility to red has any great place. Thus the sensation of yellow is due to moderate excitement of the fibres sensitive to red and green, and feeble excitement of the fibres sensitive to violet. Consequently to the person not at all sensitive to red the whole character of the sensation is altered. The fibres sensitive to green are moderately excited; there is no response to the red, and the violet is feebly excited. Thus yellow appears a decided green; red is confounded with brown and green; violet is called blue, and rose-colour is not distinguished from blue.

Besides insensibility to red there is a similar lack of perception of green—**green-blindness. Blue-blindness** is another form in which blue and green, and blue and yellow are confounded.

Red-blindness is the most common. It is inherited, as a rule, and dates from birth, and is commoner in men than women. The best test is to give the person a handful of variously-coloured wools and ask him to place all of one colour together.

In rare cases colour blindness is complete, and the person recognizes only blacks and whites.

Double vision is the result of paralysis of some of the muscles of the eyeball. The affected eye cannot be moved round in a particular direction as far as its neighbour; the correspondence between the two eyes is therefore lost, and at that point the object looked at appears double. In other directions of the eyeballs the vision is single. It is the result of tumour or other affection of the brain, such as arises in the course of syphilis. Other causes also may induce it. Accompanying it there are probably other signs of paralysis, droop of the eyelid, dilated pupil, &c., and perhaps some paralysis of the face.

DISEASES AND INJURIES OF THE EAR AND AFFECTIONS OF THE SENSE OF HEARING.

In the first part of this section the division of the organ of hearing into external, middle, and internal ear, has been described. All these parts may be attacked by disease, and all are more or less capable of treatment. It is only, however, the diseases affecting the external ear, chiefly the external canal, that can be reached by anyone who has no special knowledge. No disease of the ear, no matter how apparently trifling, should be neglected. An inflammation, beginning in the canal, may pass to the drum, pierce it, and go on to the middle and internal ear, ending in partial or complete deafness. Most cases of acquired deafness are due to such inflammation, which destroys the part of the ear designed for conducting sound, so that though the internal ear may remain healthy, it is deaf because sound cannot reach it.

Diseases and Injuries of the Ear.

The Auricle or external appendage of the ear is liable to injuries, to wounds, and bruises. These must be treated as any other wound or bruise in the manner indicated in the section on ACCIDENTS AND EMERGENCIES. It is also liable to skin affections, specially eczema. The treatment for this is described on page 318.

Inflammation of the Canal of the Ear—Boils in the Ear Canal. A boil in the ear canal is often caused by irritation from the use of ear-picks or by cold. It is sometimes a sign of a depressed state of health. A general inflammation without the formation of a boil may also arise from similar causes, or attend the progress of measles and scarlet fever, or result from injury.

Symptoms. There is pain in the ear—ear-ache—more or less intense according to the degree of inflammation. Movements of the jaw increase the pain as a rule. Hearing is diminished, and noises in the ear are troublesome. On looking into the ear the swelling of the boil may be seen—if it is not too far in—and the skin around it is red. If there is no boil but a general inflammation, the walls of the canal are reddened and swollen. The canal is also occupied in such a case by discharge, which finds its way to the outside. The ear may go on discharging for a week or two; but, if the case becomes chronic, it may last for a long time. In

the case of a boil, when matter has formed and the boil bursts, great relief is experienced, and the affection, as a rule, speedily passes away.

In the chronic form of the general inflammation there is not much pain, but there is usually some deafness, accompanied by noises in the ear. A constant sense of moisture in the ear is the chief sign, or it may be a continued flow of matter from the ear. The discharge may cease in warm weather to return again with cold, and so it may continue, if not attended to, even for years. The evil of this is that it leads to thickening of the walls of the canal, and is certain to extend to the drum and the middle ear. It may cause piercing of the drum, and may even continue its way inwards till the membranes of the brain become affected, death resulting.

Treatment.—Warm poultices should be applied over the ear and side of the head. Warm water poured from a spoon into the ear canal and allowed to remain for a few minutes is very soothing. In the case of a boil nothing relieves so much as a cut with a fine knife. This of course can only be done by a surgeon. If none is at hand the poultices and warm water must be used. In general inflammation, when the discharge appears, it should be carefully and gently washed out by syringing with warm water. The canal should then be carefully dried as far as possible with cotton-wool, and a piece of dry cotton placed in the passage. When the discharge continues for more than a week, the canal should be syringed with warm water and dried; then half a teaspoonful of a solution made by dissolving 4 grains of sulphate of zinc in 1 ounce of water should be dropped into the ear, allowed to remain for a few minutes, and then caused to flow out, the canal being afterwards dried and closed with a piece of dry wool. A solution of 2 grains of chloride of zinc to a quarter of an ounce of glycerine and three quarters of an ounce of water may be used in the same way. In *each case the solution should be warmed* before being dropped into the ear.

At the beginning of every acute inflammation of the ear a brisk purgative, salts or seidlitz powder, should be given to the patient. In weakly persons good nourishing food and tonics will greatly aid recovery.

Wax in the Ear to excess is a frequent cause of deafness. As we have mentioned on p. 356 wax is produced by glands in the canal, and its presence keeps the walls from being unduly dry. It may be present in excessive quantity either because it accumulates or because it is too freely produced. The irritation of cold, &c., will cause excessive production, but nothing does so more readily than the constant irritation of a pin or other substance used to pick the ear. Many people are in the constant habit, when washing, of twisting up a corner of a towel or other cloth and pushing it as far as possible into the canal to clean it. Others use a small sponge on a stem for the same purpose. *All such methods should be abandoned.* The cleansing of the ear by the ordinary routine of washing and drying with the finger covered with the towel is always sufficient. The other methods only succeed in pushing the wax more deeply in and blocking the canal.

Symptoms.—A gradually increasing deafness may be the only sign. Noises, buzzing, rushing noises, &c., may be heard in the ears. Giddiness is a rare symptom, and can only occur when the accumulated mass presses unduly on the drum or parts of the canal. The collection of wax may be considerable without any marked degree of deafness, and the deafness may come on quite suddenly. This is due to the canal, which has hitherto never been quite closed, suddenly being quite blocked by a small piece of wax, or by swelling of the mass already there owing to the entrance of water. Pain is not common, though it may arise from the pressure of hard masses.

Treatment.—The wax is, as a rule, easily removed by syringing. A glass syringe may be used capable of holding not less than an ounce. Care should be taken that its nozzle is blunt. A few turns of cord wound round the wide end will enable one to hold it, when in use, without risk of slipping. A bowl of warm water is used, in which a quantity of soap sufficient to make the water feel soapy has been dissolved. The syringe is worked several times to see that it is in order. The patient sits sideways to the operator, who takes the ear between the finger and thumb of the left hand and pulls it gently backwards and upwards. This helps to straighten the canal. The end of the full syringe is placed in contact with the *roof* of the canal, *just inside its opening—not pushed far in,* that is to say—and the water injected in a steady gentle stream, *never forcibly.* The process is to be repeated till all the wax is removed. Sometimes it comes away in large plugs, moulds of the canal. A bowl is held below the ear to catch the water as it escapes. As soon as all the wax is removed the syringing should be stopped. Surgeons usually have a mirror for directing light up the canal to enable

them to see when the passage is quite clear. Any person may use a small hand-glass for this purpose, reflecting the light up the canal, which is straightened by pulling the ear upwards and backwards. If this is properly done the whole length of the canal is visible in the ears of most persons, and the white glistening drum is seen at the end. At least any person with moderate skill may see whether the canal is still occupied by the dark-brown masses of wax. When the syringing ceases, the canal is dried, and a small piece of cotton placed in it and kept for a day only. No drops of any kind are needed. In all cases where the presence of wax has not set up other changes, and when the ear is otherwise healthy, improvement of hearing should immediately follow removal of the wax, though some buzzing noises will remain for a short time, as a result of the injecting.

Growth in the canal of the ear (*Polypus*). Growths are commonly the result of the irritation of discharges. They are soft red masses hanging from the walls of the canal, and may be no bigger than a pin-head or large enough to fill the canal. They cause deafness, and perhaps pain from pressure. They require cutting out.

Foreign bodies in the canal may be of very various kinds—beads, peas, small stones, insects, &c. Small bodies like beads may exist for a long time without producing any symptoms other than slight deafness and noise in the ear. If they are large, their pressure causes pain, and is liable to set up inflammation and discharge. A small pea may occasion such disturbance by swelling up with moisture and coming to press on the walls.

Treatment.—Syringing with warm water in the manner described for the removal of wax is the only safe method that unskilled persons should adopt for dislodging them. If this fails a surgeon should speedily be consulted. Much injury may be done ignorantly by trying to extract the body with pins or other instruments.

Inflammation of the Drum of the ear results from the action of cold, cold water, or is due to injuries, to the pressure of masses of wax, foreign bodies, &c. Violent syringing for the removal of wax may set it up.

Its chief **symptom** is pain, often very severe, and worst at night, preventing sleep. Coughing and sneezing aggravate the pain; and in serious cases sickness and giddiness may be present, specially in children. Deafness, and noises in the ear, attend it. In children some degree of fever is commonly present. Ulceration and piercing of the drum is a consequence of the disease. If this is not properly attended to, permanent deafness may result.

Treatment.—It is of great moment that the case should be treated by a qualified person. The only treatment an unqualified person should undertake is the application of warm poultices to the side of the head, and the dropping of warm water or warm oil into the canal of the ear. A strong dose of medicine, salts, seidlitz, &c., is useful.

Injury to the Drum is occasioned sometimes by the accidental pushing too far of a knitting-pin or such instrument with which the wax of the ear is being picked out. The membrane may be burst by a blow flat on the ear, by the explosion of artillery, or in the act of diving. It is, in these cases, caused by the sudden and strong condensation of air in the external canal.

The accident is indicated by a loud crack in the ear, by sudden severe pain, giddiness, and noises in the ear. Deafness immediately follows. Some blood may flow.

Treatment.—The ear should be closed by cotton wool. Nothing else should be done unless inflammation arise, which is treated as mentioned above.

Inflammation of the Middle Ear need only be mentioned here. It has many forms, is very common, especially in childhood, and is the common cause of deafness. One of its forms frequently arises in scarlet fever; another form is the chief cause of "running ear." In its chronic form it tends to extend inwards to the membranes of the brain, thus causing death.

In acute cases pain is the first symptom. Children are very restless with it and feverish. They scream when the ear is touched. Giddiness and sickness is common; delirium and convulsions may attend it. Usually the parts behind the ear are very sensitive to pressure. In chronic cases there may be no pain, the chief element being the constant discharge.

Treatment in acute cases must be prompt and effective. The danger is so great that no delay should be permitted in summoning a surgeon. Till one can be obtained a strong dose of opening medicine should be given, and repeated if necessary; the patient should be confined to bed in a quiet room; and hot poultices

should be applied over the side of the head, or a blister immediately behind the ear. Chronic cases require the ear to be continually kept clean by syringing, as described for removal of wax.

Earache attends all cases of acute inflammation of the ear, whether it is the external canal, the drum, the middle ear, or other parts that are affected. The presence of foreign bodies causes it; while, again, it may be a form of neuralgia, or due to the irritation of a bad tooth.

The general **treatment** consists in applying hot poultices to the side of the head, and in gently pouring warm water or oil into the canal. A good application is made by filling a soft flannel bag with chamomile flowers, which have been steeped in hot water, and using it as a pillow.

Discharge from the ears (*Running Ears*) has been sufficiently referred to under INFLAMMATION OF THE EXTERNAL CANAL, and INFLAMMATION OF THE DRUM and MIDDLE EAR. It ought never to be neglected, and all the more should it be carefully attended to if it has been long standing. It is an ignorant mistake that anything but good can arise from the stopping of a discharge as the result of appropriate treatment. If it stop of itself it may be because of some obstacle to the escape of the matter; and then naturally the pent-up fluid may quickly produce the gravest mischief. Parents and guardians who pay little heed to the "running ears" of their children are guilty of a very grave neglect of duty, and are morally responsible for any evil that may and is only too likely to arise.

Affections of the Sense of Hearing.

Deafness is a symptom of most affections of the ear. It may be due simply to accumulation of wax. If it come on suddenly without pain, in a healthy person, this is probably the cause (see p. 380). When it comes on with a cold in the head, and a sense of "stopping in the head," it is the result of the cold (see CATARRH, p. 154), and is likely to pass off in a few days. Attended by pain, ringing in the ears, &c., some degree of inflammation is likely present (see p. 381). The most intractable form of deafness comes on very gradually and painlessly, and is connected with disease of the middle ear. Usually, also, it has gone on increasing for years before advice is sought. If a skilled ear-surgeon were consulted early enough, much might probably be done to stay its progress. The sudden loss of hearing caused by bursting of the drum, as the result of violence, will pass off as the tear in the drum heals.

Deafness due to disease of the nerve of hearing is usually very intense, comes on suddenly or advances very rapidly, and is not easily reached by treatment.

Noises in the ears are present in nearly every ear disease, but they are worst in diseases of the middle ear. They readily pass off in the affections of the external ear and drum when these diseases abate, and their treatment is that of the particular affection of which they are a symptom. The chance of their being got rid of, when they are occasioned by disease of the middle or internal ear, is small.

Deaf-Mutism.

Inability to speak is in a large majority of cases the result of deafness. A person, who cannot hear either the voices of others or his own, has no inducements to utter words, and thus becomes dumb. It is naturally during childhood that this is specially shown. A child who has become deaf, as the result of disease, speedily loses the power to use language of which he had not yet obtained any mastery. A grown-up person, to whom the use of language has become a matter of habit, would not so lose the power of it, though he might lapse into silence, more or less complete according to the degree of deafness.

Children may be born deaf and thus never in the ordinary course of things become able to utter the sounds of articulate speech. In a large number of cases, however, the deafness is the result of disease arising in the course of childhood.

The **causes** of the congenital form of deaf-mutism, that is of the form dating from birth, cannot be stated with certainty. It is important, nevertheless, to observe that intermarriage, the marriage of blood relations, is held to play a very serious part in the production of the defect. For example, it has been estimated that 10 per cent of the deaf in the United States of America are the offspring of parents nearly related. It is not necessary that the children of deaf-mute parents should also be deaf-mute; but the risk is considerable that they will be so, especially if both parents are deaf. This applies,

however, only in those cases where the deafness of the parents arose before birth, and not where it has been the accidental result of some disease of childhood. The causes of deafness arising after birth are numerous. Scarlet fever is one of the commonest because of the disease of the ear so rarely absent from this fever (p. 381). Next in order of frequency as a cause is disease of the brain, some form of meningitis (p. 100), or water in the head (p. 102), measles, typhoid fever, whooping cough, mumps, scrofula, inflammation of the lungs, diphtheria, and accidents of various kinds.

Treatment.—It is sometimes the case that a child, apparently deaf, possesses some slight degree of hearing; and, in a few cases where the deafness is the result of some acquired disease, something may be done to improve the hearing. It is, therefore, of great consequence that parents should early detect defects of hearing in their children and promptly seek skilled advice. Where the degree of hearing is slight, parents are too apt to conclude that it is useless to attempt to train the child in the ordinary way, and to allow it to grow up as if it were absolutely deaf, teaching it by signs only. When the child can be made to hear by loud distinct speaking, close to its ear, the parents ought to take the utmost pains to teach it in this way, and ought to make use of signs as little as possible in order to enable it to acquire a knowledge of words.

There are two methods of teaching deaf-mutes, one by means of signs and by the manual or finger alphabet, called the French system, and the other by lip-reading and articulate speech, or the German system. The manual alphabet for two hands is usually employed; but it is adapted also for one hand only. In lip-reading and speech the deaf-mute is taught to put his vocal organs into the positions by which the various sounds are produced, and to understand what is said to him by the position of the lips, mouth, &c., of the person speaking to him. This method has been attended with very considerable success, so that on leaving school the deaf-mute is able to converse with his teachers, family, and intimate friends, on ordinary subjects. In rare cases the deaf-mute is able to converse freely and easily with strangers. The time required to attain moderate proficiency in lip-reading and speech is ten or twelve years, and the child should begin to receive instruction early, at the seventh year of age if possible.

A system of signs for instruction in lip-reading and speech has been designed by Prof. A. M. Bell of England, and extended and developed by his son Prof. Graham Bell of New York, the inventor of the telephone.

The modern system of caring for and educating deaf-mutes has shown that deaf-mutism is not necessarily associated with any degree of mental or moral defect. In some cases the defect is undoubtedly associated with feeble-mindedness, and is only one evidence of impaired development, but it is not necessarily so. With deafness one great avenue of the mind is closed up, and, if no effort is made to supply its place, the intelligence must suffer from want of development. If pains are taken to open up other avenues, it is abundantly shown that in the large majority of cases education becomes as effective as if supplied through the channels of hearing.

The Care of the Eyes and Ears.

The Care of the Eyes. A common-sense rule should be applied to the eyes and ears as to other organs. We know that excessive use of a muscle produces a sense of tiredness, and that the sensible course is to give the muscle rest for a season. The eye may also be tired with much work, and on signs of fatigue showing themselves the organ should be rested. Some persons cannot read or write or otherwise use the eyes for close work without a feeling of pain and stiffness. This is often due to some degree of redness, and perhaps inflammation, of the lids; but it is more often a sign of some amount of long-sightedness. Persons who suffer in this way should, therefore, have their sight tested. Spectacles for reading or fine work may be found completely to relieve the feeling.

In reading or writing, or in similar occupations, the head should not be allowed to hang down and forwards. This position prevents the due return of blood from the head, and is bound to produce some discomfort if nothing else. The way in which light falls on the work is of importance. It should come from the side, but so that the arm or hand may not intercept it. It ought not to be allowed to fall upon the face and eyes, or in any way to produce dazzling. The light ought to be sufficiently clear to render the work, writing, reading, &c., quite distinct without need of peering. Direct sunlight is bad, and so is a very brilliant artificial light. A mellow light, such as is given by a good reading-lamp, is best. Above all, the light should be steady and not flickering. For this reason much reading in railway carriages, or under similar

circumstances, where complete steadiness is impossible, is injurious.

Under certain circumstances it is necessary to shade the eyes. In driving against a strong wind, for example, the eyes should be protected lest inflammation of the delicate membrane (conjunctiva), lining the lids and part of the eyeball, be set up. For the same reason persons should guard against sitting in a railway carriage by the side of an open window, facing the direction in which the train is going, if there is any wind. The eyes should also be protected from the glare of a bright sun reflected from calm water when sailing, from similar glare reflected from white pavements in cities, and specially from the glare of the sun reflected from fields of snow. Spectacles of plane smoked glass are best for these purposes.

Special care should be taken with the eyes of children in the directions already indicated. They should not be allowed to read too long at a time; the table or desk at which they sit should be of a height to keep the head erect, and should be placed in the position referred to as regards the admission of light. Books printed in clear bold type should be placed in their hands so as to avoid straining their unaccustomed eyes, one of the most frequent causes of squinting (p. 376).

The Care of the Ears consists mainly in avoiding the use of pins, &c., for picking out wax. The necessary cleansing is sufficiently performed by the little finger or the corner of a towel. Wool should not be worn in the ears except when specially needed. It may be placed in the ears before entering water to bathe, and should be removed on coming out. Avoidance of vigorous nose-blowing will aid in preventing water that may have entered the nostrils from passing up the tube from the throat to the middle ear (eustachian tube, p. 356). No discharge from the ear should be left unattended to for a single day after its appearance (see p. 382).

SECTION XIII.—ACUTE INFECTIOUS DISEASES: FEVERS.

Infection and Contagion:

The Relation of Living Organisms to Putrefaction and Disease—Germs of disease—Micrococci, Bacteria, Bacilli, &c.—Their characters and mode of growth.

Disinfection:

Disinfectants;
How to disinfect a patient's body, nurses' hands, clothes, discharges, rooms, &c.;
Rules for disinfection.

Infectious Fevers attended by Rash (Eruption):

Scarlet Fever (*Scarlatina*);
Measles (*Rubeola*)—German Measles;
Small-pox (*Variola*);
Vaccination (*Cow-pox, Vaccinia*);
Chicken-pox (*Varicella*);
Typhus Fever;
Typhoid Fever (*Enteric Fever—Gastric Fever—Intestinal Fever—Bilious Fever*);
Dandy Fever (*Dengue—Break-bone Fever*).

Infectious Fevers not attended by Rash:

Influenza (*Epidemic Catarrh*); *Hay-Fever;*
Whooping-Cough (*Chincough*—(Scotch) Kink-hoast);
Diphtheria and Croup;
Relapsing Fever (*Famine Fever—Seven-day Fever—Irish Fever—Bilious Remittent Fever*);
Plague (*Pestilence—Pest—Black Death*); *Yellow Fever* (*Black Vomit—Yellow Jack*);
Hydrophobia (*Dog Madness—Rabies*);
Glanders and Farcy;
Syphilis;
Cerebro-Spinal Fever (*The Black Sickness* (popular, Dublin)—*Spotted Fever*).

Non-Infectious Fevers:

Ague (Intermittent and Remittent Fevers—Marsh Fevers);
Rheumatic Fever.

INFECTION AND CONTAGION.

Formerly a distinction was drawn between diseases that were *infectious* and those that were *contagious*. The word infectious used to be employed in a vague way to imply the nature of a disease that could be communicated to a person without any apparent introduction

of poisonous material into his body, a disease that somehow was about in the atmosphere; while a contagious disease was one which required the direct passage of the unhealthy stuff causing the disease into the body. This distinction has been broken down, and infection and contagion are now known to mean practically the same thing. The answer to the question of what exactly they do mean, opens up one of the most interesting and most recent chapters of medical science, a general account of which may be given.

About the middle of the seventeenth century one Anton Leeuwenhoeck lived in the town of Delft, in Holland, as the steward of a judge there. He was accustomed to employ his leisure in making little lenses wherewith he magnified and examined the structure of such things as butterflies' and gnats' wings. He had great skill of hand, and made several hundred lenses, each one to suit some particular object he wished to examine. With such a simple instrument, in April, 1675, did Leeuwenhoeck reveal a new and hitherto unsuspected world of living things. He placed under one of his simple microscopes a glass of rain-water, and perceived a multitude of variously-shaped bodies darting to and fro. Further experiments showed their presence in various organic (that is animal and vegetable) infusions. Hence these animalculæ, as their discoverer supposed them to be, have been termed **Infusoria.** But whence came they? Was it true, as the philosophers of antiquity believed, that organic substances, decaying animal and vegetable matter, with sufficient air and moisture, could, under the influence of heat, beget anew living things? Could "the sun breed maggots in a dead dog, being a god kissing carrion?"

Now it so happens that, thirty-seven years before Leeuwenhoeck's discovery, a similar question had been distrustfully put by a physician of Florence, François Redi, and had been triumphantly answered in the negative. Redi was not satisfied that the sun could "breed maggots in a dead dog" or in any other kind of dead meat, and he put the question to the test of an experiment as simple as it was conclusive. In hot weather he placed some fresh meat in a jar whose mouth he then covered with gauze, and in another but uncovered jar he placed a similar piece of meat; and he observed that while the exposed meat speedily swarmed with maggots, that under cover, though it became stinking, remained free of maggots. The maggots were not, therefore, the products of putrefaction, but their true cause was speedily apparent. For he noticed that multitudes of flies buzzed about the gauze, on which maggots were bred from eggs deposited there by the flies. The maggots were then not the products of dead organic matter, subject to heat, air, and moisture, but the direct offspring of living things. Could this explanation be applied to the infusoria of Leeuwenhoeck? and were they also hatched from eggs, or in some way the offspring of preceding infusoria like unto them? This was a much more difficult question, and not, at first sight, capable of a test so simple as Redi's. Moreover, other observers flocked to the new field of investigation opened up by the microscope; the simple microscope was improved on; and, as the instrument became more and more powerful, smaller and still smaller living things came into view, till some were clearly revealed that would appear as mere points under Leeuwenhoeck's simple lens; while the modern compound microscope now discovers others as invisible to the simple lens as the infusoria are to the naked eye. The problem to be answered does not alter with the diminution in size; the same question is raised, Whence come they? In every organic infusion left standing for a day or two, more or less as the weather is cold or warm, in every organic infusion they swarm in myriads. Are they begotten by the mere breaking down, the decomposition, the putrefaction, the death and decay of the organic substance, or are they developed from eggs or in some other way the direct offspring of ancestors like themselves? Another very simple experiment seemed to settle the question, an experiment devised in 1748 by an English Catholic priest named Needham, in association with the French naturalist Buffon, but only perfectly carried out seventeen years later by an Italian philosopher, the Abbe Spallanzani. Its purpose was the same as Redi's, to keep an organic substance so that nothing could alight on it from without, in order to find whether, under these conditions, living things could develop within it. So minute are the organisms, however, that multitudes might be deposited unseen from the air during even a moment's exposure. With great ingenuity were the altered circumstances met. It was argued that heat would destroy the organisms, as it destroyed other living things. So an organic infusion was placed in a flask and boiled, and after it had been boiled for some time the neck of the flask was sealed by melting it in a flame, so that any living thing in the flask must have been killed and no fresh supply

could enter. When this had been properly done no animalcules ever appeared in the flask. The experiment is open to criticism. When one boils the infusion, the steam with which the flask is filled drives out the air, and by sealing the neck none can enter. It may be that living things can be spontaneously developed from organic infusions, but only in the presence of air, and the experiment has excluded air. In more ways than one was this criticism answered. In 1854 two German observers, Schroeder and Dusch, boiled organic infusions in flasks, but instead of sealing the neck of the flask they simply plugged it, when the steam was issuing from it, with a firm plug of cotton wool. As the infusion cooled, air entered the flask, but was filtered on its way by passing through the wool. These infusions developed no living things. Than this even a more remarkable demonstration was given by the great French chemist, Pasteur, in 1862. He used a flask having a very long neck with a very fine bore. When the infusion was boiling he bent the neck downwards by the aid of heat. Air could freely enter, but it must pass upwards, not downwards. Any solid particles present in the air could not ascend with it, and so the air when it reached the infusion was free of them. In these flasks also no animalculæ were developed. But a second ground of criticism remains. It might be said, it is possible that an organic infusion which, before being boiled, might have been capable of spontaneously giving rise to living things, has been rendered incapable of doing so by the boiling, not because the heat has destroyed any eggs, seed, or other living thing from which a progeny could have been developed, but because the heat has somehow altered its constitution, just as heat will take the temper out of a spring. This too is easily answered. Break off the sealed end of the flask and leave the flask open but undisturbed, or remove the cotton-wool plug; in a few days the flasks, which for months, or for years may be, have remained free from putrefaction, swarm with life. Or as Pasteur did, drop a small fragment of the wool plug through which the air has been filtered into the infusion, within hours it is alive. Without doubt, then, the microscopic life that decaying animal substances contain in exuberant prodigality is not the outcome of some rearrangement of the particles of the dead matter, but is the product of previous life. But these and similar experiments reveal another fact—organic substances or fluids treated as in these experiments not only remain free from animalculæ but exhibit no sign of decay, no evidence of decomposition, no symptom of putrefaction. But let fall into the fluid from the point of a needle, or insert into the organic substance, a tiny speck of matter in which a microscope has exhibited animalculæ, at that point putrefaction begins, from that spot it spreads, decomposition wherever the organisms have contrived to push their way, no taint whatever in the spot to which they have as yet been unable to advance, but speedily pervading and permeating the entire fluid or solid till it is one mass of corruption. Thus, just as Redi showed, that by excluding the blow-flies dead meat ceased to breed maggots, even so later experimenters have shown that by excluding the air, or rather by purifying it from the eggs or seeds, or whatever they be which throng in it, and which it sows on all it comes into contact with, by excluding or purifying the air the dead meat will likewise cease to stink.

This gives a very brief historical summary of the various stages in the discovery of new realms of life, whose inhabitants, though themselves invisible to our eyes, yet obtrude themselves by their ravages before our senses in various offensive ways.

They and their ways must now be described in some more detail, since their significance in men's lives is even more wide and appalling than experiments up to a comparatively recent date seemed to indicate.

The name infusoria was applied to the organisms discovered by Leeuwenhoeck, but the much more minute living things rendered visible by more powerful lenses were up to a late period all classified under the term **Bacteria**, which is a Greek word (*baktērion*) meaning a little staff.

Their excessive smallness is beyond one's power to imagine. Under the highest power of improved microscopes, which magnify about 4000 times, they appear like the periods and commas of ordinary type. If a man could be magnified by the same amount he would appear as huge as Mont Blanc or Chimborasso. In comparison to the size of an ordinary man a bacterion is as a grain of sand to Mont Blanc.

Workers with the microscope were not long in discovering that even among these smallest forms of life there was as great variety as among higher and larger forms. Indeed differences which they manifested were too great to permit them to be placed all together as members of the same class or order. Various classifications have been proposed for them, which it

is unnecessary to state here. It is desirable, however, to note and remember several of the chief types. The differences which exist between them are largely in size and form, to some extent in mode of multiplication. In one thing they all agree. They all consist of a kind of protoplasm, a jelly-like substance resembling white of egg, which is clear and transparent, without any indication whatever of separation into organs, but exhibits sometimes minute bright particles of oil. The protoplasm is inclosed by a membrane formed of cellulose, capable of resisting the action of acids and alkalies.

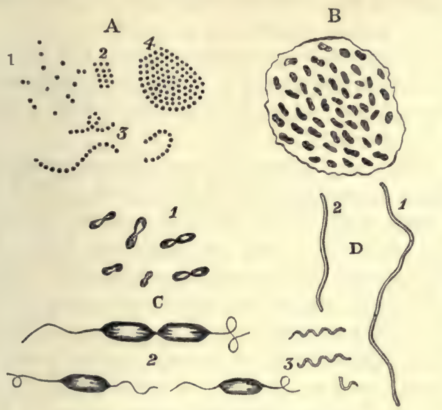


Fig. 178.—Various species of Micro-organisms.

A. Micrococcus: 1, singly; 2, in groups; 3, in chains; 4, in mass. B, a mass of Bacteria (Zooglœa mass). C. Bacteria: 1, singly, constricted in the middle, as about to divide into two; 2, shows, in a much more highly magnified view, the way in which one bacterium divides into two, each half passing off as an independent form. It also shows the flagella, or lash-like tails, of the bacteria. D. 1 and 2, Vibriones; 3, Spirilla. All are very highly magnified. (After Klein and Dallinger.)

All the various kinds are grouped together as **micro-organisms** (Greek, *mikros*, small), **mycrozymes** (*mikros*, and *zumē*, yeast), or **microphytes** (*mikros*, and *phuton*, a plant). **Bacteria** is also a general name for the group, but the term is now also applied to the particular kind, for which it is better to reserve it.

The **Micrococcus** (*mikros*, and *kokkos*, a berry) is one form. It is round, and sometimes no larger than the 32,000th of an inch. It grows after a fashion common to the other forms. The body becomes narrowed in the middle, as if by a band tied round it. The constriction increases until the single round body is almost divided into two. In a brief time the connecting thread is severed and the organism is completely split into two, each of which now has an independent existence. In a short time each one of the two divides, so that from the original *one* there are now produced *four*. This process of multiplication is called **fission**. In Fig. 178, A. are shown micrococci, some of them singly, others in groups, some in chains, and one large mass. The various kinds of grouping are due to their rapid multiplication in the manner described. The large mass is held together by a fine transparent material in which the organisms are imbedded.

The **Bacterium** is another kind of micro-organism. It is rod-shaped, about $\frac{1}{10,000}$th of an inch long, and a third less in breadth, and it has rounded ends. It multiplies like the micrococcus by dividing. The process is shown in Fig. 178, C. At 1 is seen a number of bacteria shaped like the figure 8 by the dividing process. At 2 is shown the process much more highly magnified. This part of the figure shows also that the bacterium possesses a thread-like tail at each end. By lashing movements of the threads the organism can move about in fluids. When the division of one into two is almost complete, only a long thread connects the two halves. This finally breaks in the middle, and each half moves away as an independent being, as shown in the figure. Besides growing in numbers in this way, Dallinger has shown they may multiply in another fashion. He has watched two bacteria meet and become fused together into one mass, losing their tails and becoming motionless. After a time the mass looks very granular. Finally it bursts, and there pours out a cloud of exceedingly fine particles. After watching the cloud of particles for some time Dallinger saw fully formed bacteria issuing from it. In fact the particles were spores or seeds, which, in a sufficient time, with the aid of heat, moisture, and nourishment, developed into the adult forms. This is **multiplication by spore formation**. In two ways, therefore, bacteria multiply.

The **Bacillus** is a third form of micro-organism. It also is rod-shaped (Latin, *bacillum*, a

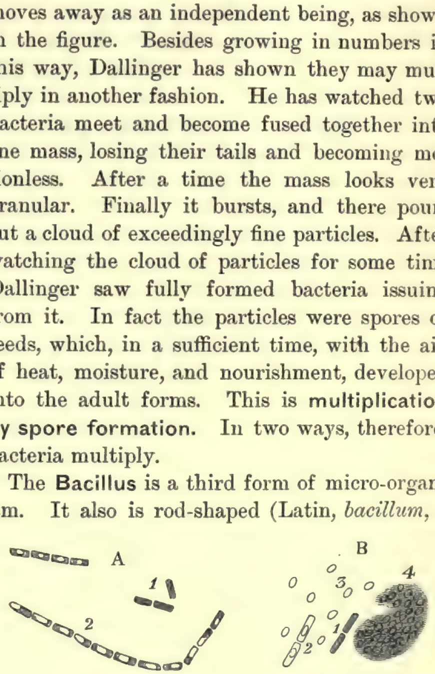


Fig. 179.—The Bacillus of ordinary putrefaction.

A. 1, single bacilli; 2, bacilli forming threads and developing spores. The bright oval body in the centre of each bacillus is a spore. B. 1, ordinary form without spores; 2, with spores; 3, free spores; 4, a mass of spores. (After Klein.)

little rod). It is larger than the bacterium. Bacilli are particularly apt to form long chains or threads, being strung on end to end as they increase in numbers. They increase both by

division and by spore formation, like the bacteria. Fig. 179, A. 1, shows three bacilli. At 2 is seen a chain. In the body of each bacillus is seen a bright oval dot. This represents a seed or spore. It increases in size at the expense of the jelly-like material forming the substance of the organism, till it bulges out the inclosing membrane. At last the membrane bursts, and the spore is discharged. If it is surrounded by nourishing material it will develop into the full-grown bacillus. If not so favourably placed it may still retain its vitality. In fact spores may be exposed to all kinds of unfavourable conditions—to cold or to heat; they may become dry and be dispersed as dust. But let this apparently lifeless dust be brought into favourable conditions of moisture and warmth, with nourishment at hand, and forthwith the spores will grow, and adult forms will be produced from them in abundance. Fig. 179, B. shows bacilli with spores, and a mass of spores.

The **Vibrio** (Fig. 178, D. 1 and 2) is a rod-shaped, and wavy or jointed organism. It moves about by rapid wave-like motions.

The **Spirillum** is the last form that need be mentioned here. It is represented in Fig. 178, D. 3.

All of these, we have seen, multiply by one of two ways, either by division or by the formation of spores, but the rapidity of their increase is beyond conception. In one brief hour, under favourable conditions, one may perceive the whole progress of their life history. Here is a comparatively simple calculation, but one whose results are so enormous that the authority of one of the most distinguished of investigators is given for its accuracy, that of Prof. Ferdinand Cohn of Breslau. Given that one bacterium will divide into two in one hour, then each of these two in another hour will divide, making 4, after three hours there are 8, and so on. At the end of 24 hours from one bacterium there are developed 16½ millions (16,777,216). After 48 hours the number amounts to 281½ billions, and after 3 days to 47 trillions. Into a flask containing a clear, transparent, organic fluid, and under favourable conditions, sow a drop of water containing but one bacterium, and such as this is the result. Nevertheless the multiplication is not indefinite; it is indeed strictly limited. It is from the contents of the organic solution that the bacteria obtain the nourishment for their life and growth. As soon as they have exhausted the nutriment they can no longer multiply, and will speedily cease to exist.

Accompanying their multiplication changes take place in the clear fluid which are quite visible to the naked eye. It becomes muddy, turbid, and loses its transparency. When the bacteria have exhausted the nourishing material, they fall to the bottom as a deposit, and the fluid may become again quite clear, but altered in constitution, because its complex constituents have been rent asunder to supply food to the organisms.

Now two questions arise—questions which have been already alluded to in the historical sketch given on pp. 385, 386, and the answers to which have been also indicated, but questions which must be again referred to. They are these: What is the origin of these bacteria? and what is their relation to putrefaction, from which they are never absent? To each question there are two answers: to the first, as to the origin, the old answer is expressed by the phrase, "spontaneous generation;" that is to say, organic substances may give birth to them under certain conditions of heat and moisture; the modern answer is, They have always parents like to them. To the second question, their relation to putrefaction, one answer is, They merely accompany it; the other is, They cause it, and without them it cannot be. Now, in spite of experiments like those of Schroeder and Dusch, men of high scientific attainments held and yet hold the view of spontaneous generation. It does seem absurd to believe that one cannot expose anything to the atmosphere for a single instant without there being deposited on it invisible particles of dust, including seeds, spores, or germs of bacteria or bacteria themselves, which await only a favourable opportunity to develop and attack, if it is liable to attack, the substance to which they have adhered. But this apparent absurdity, by a series of beautiful experiments, was shown by Prof. Tyndall to be a fact. Everyone knows that if a room be darkened by closing the shutters, and if a beam of sunlight be allowed to enter by a chink or crack in the shutter, its track will be revealed by myriads of dancing motes that catch the light and disperse it. The track of a beam of the lime or electric light will be shown in the same way. But for these dancing particles of dust the light would only light up the object on which it fell, its pathway would be invisible. Tyndall constructed a chamber whose top, floor, back, and sides were of wood, and whose front was of glass. In the floor were openings through which test-tubes were passed, their mouths opening into the chamber. A strong beam of light

was thrown into the chamber, its path being clearly visible owing to the dancing particles. The chamber was then allowed to stand undisturbed; and three days later, when a beam of light was again thrown into it, *its pathway was invisible.* This showed that the air was perfectly free from suspended particles, which had all attached themselves to the sides or fallen to the bottom of the chamber. Into the test-tubes an organic fluid, capable, therefore, of decomposition, was carefully poured through an opening in the roof. The projecting ends of the tubes were allowed to dip into a bath of brine, which was boiled for 5 minutes. The bath was then removed and the chamber allowed to remain. For months it stood, the fluid showing no signs whatever of putrefactive change, while the fluid in similar tubes, subject to the same treatment, but standing in the open air of the laboratory, rapidly decomposed. But a few days after the chamber had been disturbed, so as to raise the dust, the fluid in every tube gave way and was found to swarm with bacteria. Experiments with all sorts of infusions gave precisely similar results. Moreover, Tyndall showed that air strained through cotton wool or heated by passing through a red-hot tube no longer revealed the pathway of a beam of light—was deprived, that is, of solid particles, thus explaining fully how air admitted to flasks plugged with wool did not produce decay in any organic material in the flasks. In truth these and multitudes of other experiments show convincingly that the air is everywhere laden with solid particles, including germs which, sown on suitable soil, rapidly multiply, their multiplication being accompanied by all the stages of putrefaction. They exist everywhere, but more thickly spread in towns than in the country, becoming fewer as one recedes from human habitations, but they are present, nevertheless, in the atmosphere far removed from human dwellings, on the heights of the Alps as in the most densely-peopled valleys.

It is by the French chemist, Pasteur, however, that the most complete and brilliant series of experiments was performed that disposed of the theory of spontaneous generation.

He was led to these experiments by studying the action of yeast. Leeuwenhoeck had noticed little round bodies in beer, and in 1837 Cagniard Latour had observed that the fermentation of beer was accompanied by the growth of these little bodies. They are called torulæ, and are not bacteria. They are round or oval, and multiply by budding. But Pasteur proved that the fermentation was the expression of the active life of this small cell; that, to obtain certain materials requisite for its nourishment, it attacked the sugar present in the fluid, and as a result of splitting it up produced carbonic acid and alcohol. From the fermentation of beer he passed to the butyric and lactic fermentations—actions whose results anyone may see by watching the process of the souring of milk. He demonstrated that in each case the fermentation was the work of an organism introduced from without. The production of vinegar he showed to be also the work of a bacterium. Introduce yeast into beer-wort, it grows and flourishes, and alcohol and carbonic acid gas are formed. But the yeast soon exhausts the material on which it grows, and immediately its own activity ceases. But it has not exhausted the capacity of the liquor to nourish various other kinds of living things. This is the golden opportunity of bacteria, which may then become active, and by the fermentive process they in turn set up beer becomes sour. Beer, vinegar, and wine in turn received Pasteur's attention, and in each case he separated the living agent, different in each, whose growth was the direct cause of the change. Let bacteria foreign to the fermentation proper in each case be introduced, and beer becomes sour, vinegar becomes flat and tasteless, wine is converted into vinegar. These questions were inextricably interwoven with the wider one of spontaneous generation. This Pasteur also attacked by means of such experiments as have been indicated, though not in their historical order, and which Tyndall's experiments, performed later, amply verified, so that Pasteur was able to declare: "There is not one circumstance known at the present day which justifies the assertion that microscopic organisms come into the world without germs or without parents like themselves. Those who maintain the contrary have been the dupes of illusions and of ill-conducted experiments, tainted with errors which they knew not how either to perceive or to avoid. Spontaneous generation is a chimera."

But many observers have taken organic infusions—an infusion of hay, for example—have boiled them in flasks, duly sealed the necks, and have laid them aside, and yet after a sufficient time bacteria have been found in them multiplying. Such results have been obtained by the most experienced observers, when no doubt existed as to the experiments being well conducted. The explanation in due time was forthcoming. The fully-developed bacteria are

destroyed by a temperature much below that of warm water, not so their spores. These seeds, or eggs as one may call them, resist the temperature of boiling water, prolonged even for several minutes, and in some cases even for hours, so that, when set aside, by and by the boiled infusion will give way owing to the growth of the eggs to the fully active bacteria. Indeed they are unusually resistant, defying the action not of heat only, but also of extreme cold. One may freeze the solution containing the bacteria, one may keep them for hours at a temperature many degrees below zero, the bacteria themselves die, but their spores are only dormant, and will awake up to life soon after the usual temperature is restored. Drying they successfully encounter as well as the action of many chemical agents.

Thus one objection after another has been set aside, till it becomes conclusively evident that there is present in the atmosphere a vast number of germs of various kinds, each kind capable of setting up a fermentation peculiar to itself, that putrefaction is only one kind of fermentation, the expression of the life and growth of a particular germ whose activity liberates from the organic substances on which it lives sulphurous and other badly-smelling gases, and that, if by any means the organic substance is kept free of the living things, it will not putrefy, will not break down, but will remain in its organized though lifeless condition.

From this point of view the germs of putrefaction cease to be mere interlopers, parasites, breeders of corruption. They come to occupy a recognized and legitimate place in the constitution of nature. Nay, not only do they fill a recognized place, but they discharge a necessary function, they play indeed a beneficent part in the drama of life. The world of lifeless matter consists—let it be put roughly and broadly—of a number of elements, carbon, oxygen, hydrogen, nitrogen, sodium, potassium, phosphorus, sulphur, &c., associated together in various ways, oxygen and hydrogen as water, oxygen and nitrogen as atmospheric air, potassium, sodium, phosphorus, in various combinations as salts of various kinds. Now these substances are just such as plants, the lower animals, and man require for their nourishment. But neither the lower animals nor man can take these inorganic substances and convert them into the living matter of their bodies. A diet of phosphate of lime, chloride of sodium, and potassium, charcoal, and so on, with a liberal allowance of air and water, though containing the same elementary substances as are found built up into muscle, nerve, and bone in a human body, is but as the sand of the desert to a hungry man. Six feet of earth may be a liberal allowance for his grave, but not for his repast. Not so with the plant. From the earth in which it is rooted, from the air to which it stretches its arms, it draws just the same elements as have been named, and builds them up into much more complex forms, into highly-organized substances. On these complex combinations of the same original elements animals and man can live. The ox crops the herbage and builds up in its own body into still higher forms the organic substances the plant yields to it; and man in turn derives nourishment from the substances the plant and the lower animal prepare for him, composed though they be of the same materials which, as beggarly elements, are practically valueless for him. And now what would happen, suppose there was ever a building up and never a breaking down? The plant, which is the first workman in nature's great manufactory, which performs the first stage in the process of converting the raw material into the finished article, the plant cannot live on boiled mutton, nor yet can it feed on the bodies of its dead companions. It is the elements it seeks. But if it is perpetually building up the elements into organic substances its own supply of nourishment will some day be exhausted, it will cease to live. If balance is to be maintained, the process by which organized bodies are broken down into elements must keep pace with the process by which elements are built up into organized bodies. Death is necessary to life. This breaking-down process the lower animals and men to some extent accomplish. A man eats bread and meat, he takes into his body complex substances, he transforms them into material for his use; they abide in his body for a longer or shorter time, give him the means of obtaining heat and energy, and are then cast out, as carbonic acid gas, water, urea, and salts—practically restored, that is to say, to their elementary form, broken down from their complex state. But animals and men die. Their bodies are masses of complex, organic substances, in that form useless for any practical part in the cycle of life. But now to sweep away this useless mass an invisible host of busy workers descends from the air, who take possession of the body, send detachments far and wide into its inmost recesses, and rest not day nor night till they have rent asunder from one another the wondrously piled molecules of

albumen, of fat, of nerve, of blood, till they have broken down the walls and torn from one another the stones of the tabernacle of flesh—till they have restored again to earth and air that which years before the plant took from them. No putrefaction without organisms; and thus life presides over the work of death.

Now, these facts that have been stated supply the foundation of the modern view of infection and contagion. The resemblance between fermentations and putrefactions and various diseases, specially those of an infectious or contagious sort, had long ago been remarked; and if the one set of occurrences was the work of organisms or germs, why not the other? Why not? In 1850 a French doctor, Davaine, on examining with the microscope a drop of blood from a patient who had died of splenic fever, observed little thread-like bodies about twice the length of a blood corpuscle. He paid little heed to his discovery. But in 1863, excited by the proof Pasteur had meanwhile offered of organisms of a similar nature being the cause of various fermentations, he made new observations, and found the same thread-like body constantly present in the blood of sheep and rabbits dead of the disease. These are the first definite observations that link contagious diseases to the life and growth of germs.

Now it so happens that about the same time ruin was threatened to one of the industries of France, that of silk culture, by the presence of a mysterious disease among the silk-worms that spread like a plague not only in France, but in Spain and Italy as well. In 1865 the loss to France by its ravages amounted to over four million pounds sterling. No measure that could be thought of seemed of the least value to stay its progress. In the distress the government of France turned to Pasteur, who had taught the French wine-growers how to prevent disease in their vines, and besought him to render his assistance. He visited the affected districts, and was speedily able to affirm that the disease was due to the presence in the insects of minute cylindrical bodies about $\frac{1}{6000}$th of an inch long, and therefore only discoverable by the microscope. These microscopic organisms had been observed years before by an Italian naturalist, Filippi; but whether they had any connection with the disease was not known. Pasteur proved they were the cause of the disease, and that it was contagious. He showed that if a silk-worm, in whose body the round bodies were present, was pounded up with water in a mortar, and the poundings painted with a brush on the leaves on which healthy worms were fed, they would all without fail be smitten with the plague. For three years he worked at silk-worm disease, and succeeded, with grievous injury to his own health, in unearthing its precise nature and in devising means for its arrest, by the adoption of which prosperity was restored to this industry. During this time, and for some years after, a hot discussion had been going on about Davaine's discovery of bacilli in splenic fever. In 1876 a young physician living near Breslau, Dr. Koch, published a paper giving a full account of the life history of the splenic-fever bacillus, and a complete demonstration that its introduction into the body of animal or man was the only cause of the disease. In the following year (1877) Pasteur, driven into the question of contagious diseases by his experiments on beer, wine, and silk-worm diseases, investigated the question, and confirmed and extended the results of Koch. Now what of splenic fever? It may attack the horse, the cow, the sheep, and man. In some years France lost by it in cattle from a half to one million pounds sterling. It is rampant, not in France only, but in Spain, Italy, Russia, and Egypt. It has appeared in this country, *transported from Russia by hair*. It is sometimes called *wool-sorters' disease*, because in this country it has been chiefly wool-sorters that have been attacked by it. The evidence is conclusive that the hides had been those of animals dead of splenic fever. Some of the blood of the animal containing the germ that is the cause of the disease, had soiled the skin and the bacillus had produced spores. These seeds had clung to the hairs, and in spite of drying had retained their vitality. In the process of sorting they had been detached and had gained entrance to the bodies of the sorters by the breath or in some other way.

It is worth stating what is the general method adopted in investigating the nature of micro-organisms. By the use of very highly magnifying powers, and by the use of staining agents, they can be seen under the microscope. In the blood of an animal dead of splenic fever an organism was discovered by means of the microscope, but no information could thus be gained as to its relationship to the disease. Often, moreover, various kinds of such living things were found, and the question arose which kind, if any, was it that produced the disease. Experimenters, therefore, attempted to grow artificially the different organisms. Some flourish and multiply in chicken-broth, others grow

well on gelatine, some on raw potatoes, while various other solids and fluids were found capable of nourishing them. Experiment showed, moreover, that a particular form of organism flourished so well in one particular fluid that, though this kind with many others were put into a flask of the fluid, the particular form took entire possession of the fluid, and no other had a chance of life against it. Here, then, was a method of sifting out one kind from another until a fluid, containing one form only, was obtained with which to experiment. Thus a drop of blood taken from an animal dead of splenic fever is placed in a flask containing meat-broth, which has been shown to be free of germs of all kinds by having stood for several days or weeks, after being boiled, without the least trace of decomposition occurring in it. The flask is plugged with wool, and is maintained at a certain heat. In a few hours the bacilli of splenic fever, present in the drop of blood, have multiplied enormously. If other kinds of organisms were present in the drop they may have grown too, but to a less extent, because the soil, so to speak, is not so suitable for them. From this flask a drop of fluid is taken and transferred to a second flask containing the same pure broth free of germs. The special bacillus multiplies here again, other forms less. From the second flask a drop is transferred to a third, and so on through six or seven flasks, till a fluid is obtained containing the one particular organism only, all the others having died out. This flask now contains what is called a **pure cultivation.** Now if the bacillus contained in this fluid is the cause of splenic fever, then the injection of a small quantity of the fluid into an animal, capable of taking the disease, ought to produce the disease in the animal. If it produces the disease, then in the blood of the animal the same bacillus should be found, and from a drop of the blood new quantities of the organism ought to be capable of being reared, by means of which, in turn, the disease can be again communicated. All these different processes must be gone through before it can be said with perfect certainty that the particular germ is the active cause of the particular disease. Besides all this, it is plain that when a cultivation of the germ is obtained, experiments may be performed to determine what substances hinder and what aid its growth, whether carbolic acid, Condy's fluid, or other agents, kill it, and so on. By such means information may be gained that would enable the disease to be arrested or stamped out.

A remarkable illustration of this may be given from Pasteur's work. He found that hens never took splenic fever, and that the disease could not in an ordinary way be communicated to them. Now a degree of heat equal to 44° Centigrade kills the splenic-fever bacillus, and the heat of hen's blood is 41° or 42°. He thought perhaps the high temperature of the fowl's blood prevented it from taking the disease. So he took a hen and placed it in a cold chamber till its bodily heat was lowered to 37°. He then injected the poison; it took the disease and died. He did the same with another fowl; but this time, at the height of the attack, he placed it in a warm chamber to raise its bodily heat up to or above the usual. It recovered. But, again, Pasteur found that an animal, that had recovered from one attack of splenic fever, was safe from a second attack. He found that he could cultivate the splenic bacillus through hundreds of generations without its violence being the least affected, provided one cultivation followed another within an interval of hours. If, however, a cultivation of the organism were left for days or months with a due supply of pure air, its violence was remarkably diminished, and *if this weakened bacillus were injected into an animal the animal was very slightly affected for a short time, but was rendered incapable of acquiring the fatal form of the disease.*

Pasteur announced his discovery; he was offered a test and accepted. In May, 1881—probably many remember an account of the experiment in the papers—in the presence of veterinary surgeons, agriculturists, and others, a flock of 50 sheep and 10 cows were brought before him. Into the bodies of 25 sheep and 6 cows he introduced some fluid containing the weakened germ, the remaining 25 sheep and 4 cows were untouched. Three weeks later the most fatal form of the poison was injected into the bodies of all the 50 sheep and 10 cows. Two days later the 25 sheep that had not received the weakened germ were dead, and the 4 cows were very ill, while the 25 sheep and 6 cows which had received it were comfortably browsing. Since that day, up to the end of 1883, more than half a million of animals were vaccinated (so to speak) in France against splenic fever, with a consequent reduction of the death rate from that disease to $\frac{1}{10}$th of what it was among non-vaccinated animals.

Briefly, then, splenic fever has been found to be due entirely to the presence in the body of the affected animal of a particular living organism, and the result of that knowledge has

been to indicate the means for stamping out the disease.

The true nature of another disease, that of tuberculosis, has within recent years been revealed by methods of inquiry similar to those just described, pursued by the distinguished German observer, Dr. Koch. It has been stated (p. 278) that tubercle is the chief cause of consumption of the lungs and consumption of the bowels, and of some forms of inflammation of

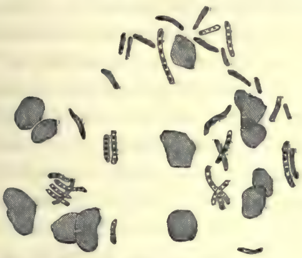


Fig. 180.—Bacilli in Spit of Consumptive Patient.

the membranes of the brain (p. 101). In the little nodules of tubercle (p. 278) Koch found a small organism, a bacillus (Fig. 180). He was able to grow it artificially, and by injecting fluid, containing his reared germs, into animals, he caused them to be affected by the disease. In the spit of consumptive patients the tubercle germ is found. The spores or seeds of the germ are not destroyed by drying, so that when the spit has become dry the seeds may be wafted about in the air, may be drawn into the lungs of a healthy person, may take root and grow and produce the disease. The popular objection, therefore, to sleep with, or be the close companion of one suffering from consumption, is not without scientific justification. On the other hand, the germ of tubercle needs a high temperature for its development, and it is not therefore likely to thrive in the outside world in temperate climates.

After the epidemic of cholera in Egypt in 1883, which spread to France, Italy, and Spain, investigations were undertaken to discover whether any special organism could be detected having any particular relationship to the disease. French, German, and British commissioners were appointed for the purpose. Dr. Koch, who was head of the German commission, detected a peculiar bacillus, shaped like a comma (,)—the comma bacillus, in the intestines of persons who had died of cholera, in the discharges from cholera patients, and also in water of which persons had drunk, who had afterwards been seized with cholera. He believed that this bacillus was the active agent in the production of the disease. Animals, however, are not susceptible to cholera, and the essential link in the chain of evidence, namely, the production of cholera in animals by the injection into their bodies of the pure cultivation of the organism, could not be obtained. In 1885 Dr. Klein, the head of the British commission, reported as the result of his investigations his inability to accept Dr. Koch's view. At present, therefore, the relation of micro-organisms to cholera is not definitely determined.

In the blood of persons suffering from relapsing fever another form of micro-organism—the spirillum (Fig. 178) has been found in great numbers, and during the intervals of freedom from fever they disappear from the blood. The fever has been produced in monkeys by injecting into their bodies blood from persons suffering from relapsing fever, and thereafter the spirilla have been found multiplying in the monkey's blood.

A micrococcus (p. 387) has been found in Erysipelas (Rose, St. Anthony's Fire), and the injection of the artificially reared organism into rabbits has produced erysipelas in them.

In the annual reports of the Registrar-General the following diseases are classed as zymotic, that is, as resembling fermentations, and apparently due to some poison operating in the blood, which poison might consist of living organisms such as have been described:—

Small-pox.	Erysipelas.
Measles.	Puerperal Fever.
Scarlatina.	Carbuncle.
Diphtheria.	Influenza.
Quinsy.	Dysentery.
Croup.	Diarrhœa.
Whooping Cough.	Simple Cholera.
Typhus.	Ague.
Enteric or Typhoid.	Remittent Fever.
Simple Continued Fever.	Rheumatism.

Now micrococci (p. 387) have been found in small-pox, scarlet fever, diphtheria, and in the diarrhœa of children, and bacilli (p. 387) have been found in dysentery and typhoid fever, although as yet no definite relationship has been proved between the organisms and these particular diseases. Inasmuch, however, as a micrococcus has been found capable of causing erysipelas, and bacilli of different kinds capable of producing splenic fever, consumption, and apparently cholera, it would appear probable that it needs only patient research, like that of Pasteur and Koch, to reveal the connection between all infectious disease and the growth of micro-organisms. How, precisely, the organism operates in the production of the disease it is

not easy to determine. It seems probable that the multiplying organism produces some chemical alterations in the blood and tissues of the animal attacked, and that the diseased conditions are the consequences of these alterations. The organism may do this by splitting up certain constituents of the blood and tissues in order to obtain what it requires for its own growth; or it may be that, in the course of its own growth and multiplication, the organism produces some special substance, a ferment, for example, and that it is owing to the operation of this special substance, manufactured by the organisms, that the symptoms of the disease are manifested.

These considerations have some very practical issues. Every infectious or contagious disease appears to be due to some form of micro-organism, one particular organism for each particular disease. The germ or organism of scarlet fever can produce only scarlet fever. It can never produce measles nor typhoid fever any more than from corn, sown in the ground, can a crop of potatoes be expected. Each organism produces its own disease and none other; and the special disease cannot arise unless its germ has gained entrance to the body. They may gain entrance in many ways. They may be present, like putrefactive germs, in the air, in food, in drink. They may be received on one's clothes; they may be harboured under one's thumb-nail; a hostess may dispense them with her hospitality; a friend may impart them by a kiss. But, though the channels by which they spread are inexhaustible, *they have one origin and one only*, and that is a preceding case of disease. Germs of measles, of diphtheria, of typhoid fever, can no more develop anew than can germs of putrefaction, which, it will be remembered, are always derived from parents like to them. If typhoid fever germs gain entrance to a person's body they came from the body of some one, whether he can be found or not, who had the fever before him. The organisms enter the body of a person and multiply there. They are cast off from his body, some by the air which be breathes out, some by his skin, some by the kidneys, some by the way of the intestinal canal. One kind of germ may be particularly abundant in the discharges, may be able to multiply in organic fluids, so that the smallest quantity of such a fluid gaining entrance to food or drink is capable of imparting the disease to those who partake. Another kind of germ, on the other hand, may be drowned, so to speak, in liquid, and may rather be propagated by spores suspended in the air. But that is a mere detail in the life history of the germ. In all cases, however, it is the introduction of the bacterium, the micrococcus, the bacillus, or whatever it be, it is its entrance into the body, by whatever channel, that sets up the disease.

This view of infectious diseases thus affords the hope and suggestion of a method of diminishing, if not of getting rid of, such diseases altogether, and to some extent also indicates the direction in which their cure is to be sought. If the particular organism of each contagious disease were known, the condition of its life and activity understood, and the circumstances hurtful to, or destructive of, its life fully ascertained, there is great probability that this knowledge would at once suggest a method by which its multiplication in the living body could be arrested, and the disease thus cured. Even without such knowledge, however, the view indicates the means for arresting the spread of contagious diseases and diminishing their occurrence. The means consist in preventing the spread of the germs from an existing case of disease. Too often, however, one case of a contagious disease is simply the breeding ground of a multitude of other cases, because no steps are taken to prevent the scattering abroad of the germs. To prevent such an occurrence methods are adopted for destroying the disease germs that have proceeded from the patient's body. These methods are stated under DISINFECTION.

Two misunderstandings must be guarded against. In the early part of this article the grounds were stated for the assertion that the organisms of putrefaction were everywhere, and could not be avoided. There can be no doubt that everyone daily swallows and draws into the lungs hundreds of them. These germs of putrefaction are powerless to harm the living human body. Moreover, by no possibility, it would appear, can such organisms be changed into forms capable of acting in a poisonous manner on the living body. To repeat, it is not the ordinary germ of putrefaction that does harm; it is a particular form of organism for each particular disease. The second point to be noticed is that disease germs may gain entrance to a person's body and yet he may not suffer from the disease. Just as in nature each plant grows best in a particular soil, and in some kinds of soil certain plants cannot grow at all, so disease germs may enter a person's body but be unable to thrive there. In other words, the person is able to resist the disease. Just as there are

soils that will grow anything, so there are persons who catch everything that is going.

Nothing gives a man so great disease-resisting power as good health. That man secures himself best against infectious as against other disease, so far as man can secure himself, who, besides keeping far from the source of the infection, lives regularly and temperately in diet and in conduct.

Epidemic and Endemic. It is the fact of contagion that gives the peculiar character to diseases called **Epidemic** diseases. One person affected with small-pox comes into a community. In a short time others catch it from him. Each one of these communicates it to others, and thus the disease spreads among the people. It becomes epidemic (Greek *epi*, upon, and *dēmos*, the people). Small-pox, measles, and scarlet fever are thus types of epidemic diseases, diseases capable of over-spreading a community in a brief period. On the other hand such diseases may appear here and there, not spreading for some reason or another, but an odd case occurring unconnected with others, so far as known. Such cases are said to be **sporadic.** In opposition to epidemic is the word **endemic.** The essence of an epidemic disease, as we have seen, is a poison, capable of multiplying in a human body, of being cast out of the body, and of being passed from person to person, communicating the disease. Now an endemic disease is not one which can be so passed and conveyed from one person to another regardless of place. It is linked with some particular district, so that a person is not liable to it unless he comes within the affected district, and perhaps by leaving the district he may get rid of it. It depends, that is to say, upon some peculiarity of climate, of water supply, or drainage of the district in question. Thus goitre (p. 210) affects persons living in certain parts of Derbyshire, in certain Swiss valleys, &c., and persons will not be affected by it if they keep away from the localities where it prevails. It is not, therefore, epidemic, but endemic.

DISINFECTION.

It has been shown that infectious diseases are communicated from a sick person to a healthy person by material thrown off from the body of the sick person, the active part of the material being probably some form of living organism. It has been seen that the poisonous material may come off from the patient's body in his breath, in discharges from the mouth and throat, from the skin, from the bowels, and from the kidneys. It is desirable that as soon as possible all poisonous material should be destroyed in one way or another to prevent the spread of the disease. All the means employed to accomplish this are included under the term disinfection, and the materials that may be used for the purpose are called disinfectants.

The **disinfectants** commonly used are carbolic acid, chloride of lime, Condy's fluid (which is a solution in water of permanganate of potash), sulphurous acid, obtained from burning sulphur, Burnet's fluid (a solution of chloride of zinc), sulphate of copper (blue vitriol) dissolved in water, and sulphate of iron (copperas), sulphuric acid (oil of vitriol), and hydrochloric acid (spirit of salt).

These substances ought to be used in such a way as to destroy the matter of contagion. There are some substances which, strictly speaking, do not destroy the contagious matter, but simply prevent its growth and multiplication. These are called **antiseptics**; and a good example is carbolic acid in weak solutions. The living matter of contagion cannot multiply when exposed to the action of an antiseptic, but if the antiseptic be removed the contagion may then go on to multiply. Its growth is merely *arrested for the time being*—the living organisms are not killed. There is another class of substances which may remove the offensive smell of decaying matter without killing or hindering the growth of contagion in it. These are **deodorants.** It is a true disinfecting action that is wanted, an action which will kill the contagion, so that neither at the moment nor at any future time can it become capable of doing harm.

The manner in which disinfectants should be employed for various purposes will now be stated.

To disinfect a patient's body. The patient should be kept perfectly clean. His body should be sponged daily with lukewarm water, to which a small quantity of ordinary vinegar (acetic acid) may be added. When scales or crusts are separating from the skin, the body should also be daily anointed with lard, or with olive-oil or glycerine, with every 40 ounces of which one ounce of pure carbolic acid should be mixed. This prevents the scales, &c., being scattered about in the air of the room, and at the same time acts as a disinfectant.

To disinfect nurses' or other attendants' hands, the best method is washing in water made pink with Condy's red fluid, or the permanganate of potash itself, or in water in

every two pints of which 1½ ounces of carbolic acid have been dissolved. *All dirt should be removed from under the nails in the process of washing.*

To disinfect clothes, they should, immediately on removal from the patient, be steeped for at least an hour in water, every gallon of which contains a quarter of a pint of carbolic acid. The acid is, however, dear; in its place water containing two ounces of chloride of lime to the gallon (1 pound to 8 gallons) may be used, and has the merit of cheapness. Care must be taken that only the clean water is used, containing no particles of the lime, which would burn the clothing. To prevent this a wooden tubful of the solution should be made at a time. The chloride of lime should be well stirred with a stick and then left to settle. After it has quite settled the clear liquid from the top can be drawn off as required. After steeping the clothes should be washed and boiled. Rags and scraps, not to be kept, should be immediately burnt. Articles of clothing that cannot be so steeped and washed, beds, &c., should be exposed to the fumes of sulphur, applied as directed for disinfecting rooms.

To disinfect discharges from the bowel, &c., they should be passed into vessels already containing a disinfecting solution. A cheap one is made by chloride of lime, one pound to the gallon of water. A stock of it should be kept, and some placed in each vessel as required. For the same purpose water, containing oil of vitriol (sulphuric acid), in the strength of one ounce of acid to a gallon of water, may be employed. A mixture used for the same purpose is made of 8 ounces of sulphate of zinc (white vitriol), 1 ounce of carbolic acid, and 3 gallons of water. On the whole, the chloride of lime is as useful as any, and very cheap. Plenty of the disinfectant should be mixed with the discharge. When the whole has been emptied into a water-closet the basin should be well flushed with water, to prevent the disinfectant collecting in the pipes and eating through them. If there is no water-closet—if, for instance, a dry closet is in use, as in the country—the discharge should be received in a vessel containing a solution of oil of vitriol or spirit of salt (of the strength of 1 ounce to 20 of water); chloride of lime should be added, and the whole thrown into a pit in the ground far from all wells or other water supply, and fresh earth thrown upon it. All chamber vessels should be washed in an acid solution, water containing one ounce of oil of vitriol, or spirit of salt, to the gallon.

To disinfect rooms, sulphur or chloride of lime should be used. Windows must be tightly closed, fireplaces and all crevices and cracks properly blocked up. Articles of clothing, bedding, &c., should be hung on lines. An iron vessel is placed in the middle of the room, containing one pound or more of sulphur, according to the size of the room (1 pound for every 1000 cubic feet of space), and, when everything is ready, the sulphur is to be lighted by placing a live coal on it. The door is then tightly closed and left so for 24 hours. Thereafter windows and doors are opened; and the room is freely ventilated for other 24 hours. After this has been done the ceiling should be whitewashed and the walls washed down. If the walls are papered, the paper should be washed off and burnt. Wood-work should be washed with water and soft soap. If chloride of lime be used it should be placed in a large shallow dish, and sulphuric acid, diluted with water, poured upon it. The rest of the procedure is the same as described. It is to be noted that the chlorine gas will remove the colour from coloured stuffs.

Heat is by far the best disinfectant. The best way of disinfecting beds, bedding, and articles of clothing that cannot be washed easily, is to expose them in a hot-air chamber for two hours or more to a heat ranging between 210 and 250° Fahrenheit.

As such an arrangement is only possible in hospitals, &c., and many other methods of disinfection are often not at hand, it should be stated that the sanitary authorities of Glasgow have found that thorough washing and boiling, in the ordinary way, are sufficient to disinfect them completely. In the absence of other methods, then, if all clothes of every description were plunged, immediately on removal from the patient, even before passing from his room, into tubs containing water and ordinary washing soda, and so carried from the patient's room, allowed to steep, and then washed and boiled, the risk of communicating disease by them would be reduced to very little.

Rules to be adopted in every case of infectious disease to prevent infection spreading:—

1. Place the patient in a room by himself, from which carpets, curtains, and hangings of every description, including pictures, &c., have been removed. All furniture, except a wooden table and chair, should also be removed. The room should be well ventilated. This is best done by keeping a fire always burning in the

grate. The floor should be kept clean, and sprinkled with Condy's fluid, or solution of carbolic acid, 1 ounce in 20 of water. The door should be kept closed, and a sheet should hang outside it, and be sprinkled daily with the Condy's fluid or carbolic acid solution.

2. Let none come near the room except the nurse and medical attendant. The nurse should wear some dress that will wash. She should keep her hands clean by washing, as noted above. When she must attend to other household duties, she should take off her dress before leaving the room and put on another kept hanging outside for the purpose. She should mix as little as possible with other members of the household.

3. All cups, plates, and utensils used by the patient should be passed through a solution of chloride of lime (2 ounces to the gallon of water) immediately on being taken from him, and should be afterwards washed in boiling water.

4. All towels, handkerchiefs, clothes, &c., used in the room should be steeped in the weak chloride of lime or carbolic acid solution.

5. All the patient's discharges, spit, vomit, discharges from bowels, &c., should be treated as noted on p. 396. All remains of food and drink should be similarly treated and thrown out.

6. The patient should be kept clean, as directed on p. 395.

7. On recovery, and before mixing with other members of the household, the patient should be bathed and clothed in a completely fresh set of clothing, from the skin outwards, which clothing must not have been kept in the sick room.

8. After the removal of the patient, the room and all articles of clothing left in it should be disinfected, as directed on p. 396.

9. The house should be kept clean and well ventilated during the sickness, the water-closets being specially attended to.

10. Should the patient have died, it is desirable to disinfect the body by wrapping it in sheets wet with carbolic acid solution (1 ounce of acid to 20 of water), or chloride of lime solution (1 ounce to 40 of water); and sawdust soaked in either of these solutions may be placed in the coffin.

If these rules seem troublesome to follow out, it should be remembered that the duty to the healthy is not less than to the sick; and where they are neglected and infection spreads, the moral guilt resting on those who have been neglectful is great.

INFECTIOUS FEVERS ATTENDED BY RASH (*Eruption*).

General characters. Fevers accompanied by eruptions (rashes) on the skin were classed by the old authority, Cullen, as **exanthemata.** This term is derived from two Greek words, *ex*, out, and *antheo*, to blossom, and means, therefore, a blossoming out. The phrase **exanthematous fevers** is largely used in medical works to include all the fevers, attended by rash, which are described under the above heading. They have several characters in common.

1. They are all due to the introduction into the body of some special material whose growth in the body is attended by the progress of the disease. They are all contagious or "catching."

2. The fever does not show itself till some time after the poison has obtained entrance into the body. There is an interval, that is to say, between the time the person becomes infected and the time he actually becomes fevered. This interval is called **the period of incubation.** Incubation means the act of hatching, and the idea is that the eggs, so to speak, of the disease require to be in the body for sometime before the disease is hatched out of them.

3. The hatching being completed, the fever appears, lasts a definite time, and runs a certain course in each case.

4. The disease is accompanied by a rash, of a special kind for each fever, which appears and lasts for a certain time, and goes through a regular series of changes.

5. Each fever ends at a certain time, in some cases suddenly after copious sweating or loose motions of the bowels, in other cases gradually diminishing till it has disappeared. In the former cases it is said to end by **crisis** (Greek *krisis*, a decision or turn); in the latter cases it ends by **lysis,** meaning a loosening (Greek *luo*, I dissolve).

6. The fever attacks the same person once only as a general rule.

Regarding these general characters some additional remarks may be made. The first—the catching nature of the eruptive fevers—is very important to notice. Some are much more catching than others. Most people are aware how difficult it is to prevent scarlet fever and measles from spreading, and, among unvaccinated people, small-pox. Typhoid fever, on the other hand, can be more easily confined if great care can be taken to disinfect the patient's discharges and to prevent them in any way getting near to any water supply. It is also important

to notice that in no other way can such a fever arise than by its seed having been sown. It cannot arise anew. It never can be caused by exposure to cold merely, by errors in diet, or in any such way. It cannot, therefore, arise from the entrance into a house of mere sewage gas, and the contamination of the air so caused. This is a point not quite understood. A house may be badly drained, or the drains may not be perfect, and gas from the sewers may thus pass into the house. This is undoubtedly a great evil, because the inmates of the house, breathing the bad air, are liable to suffer from headaches, sickness, sore throats, and various other states of ill-health. Still worse results may follow, for the persons, weakened in their general health, are thus ready victims for any disease they may come in contact with, and fall a prey to special diseases, which, in vigorous health, they would have had a great chance of resisting. But the gas from the drains, *pure and simple*, cannot produce measles, scarlet fever, diphtheria, typhoid fever, or any other special fever. It is only possible for such a fever to be communicated by drains, if the particular poison that is the cause of the fever, has been cast into the drains, from some house, where that particular fever already exists. The mere fact of a drain of a house being in a bad condition is not, therefore, sufficient evidence of the source of a special fever. Drains are only one of many channels along which contagion may spread.

The period of incubation (hatching) varies for different fevers, as shown in the table on p. 399. This is not to be forgotten in trying to trace the source of the disease. A person may move from one part of the country to another, and, some days after he has entered his new abode, fever may declare itself in his household. He must not, without deliberation, blame the new house. The disease may have been brought with him; and it may be his old place of living that is to blame.

While these fevers always have a definite course, the illness may not end with the natural conclusion of the fever. Some disease of kidneys, lungs, bowels, or other organ may arise in the course of the fever, prolonging the illness or causing death. It is to such causes, **complications** as they are called, that relapses are due. They are not, as a rule, renewed attacks of the original fever, but interruptions to the recovery owing to the affection of some organ that has specially suffered.

The facts that these special fevers have a regular progress of their own, and will end at a certain time, unless something occurs to disturb the course to recovery, afford important indications for treatment. So far as present medical knowledge extends, to attempt to cut short the fever at any stage is vain. Such a thing would only be attempted or suggested by ignorance. It could only be possible if one knew the real character of the material that caused each fever, and of something that was able to destroy it in the blood of the person ill, without also injuring the patient. Such knowledge is not possessed regarding any of the eruptive fevers (see CONTAGION, p. 384). All, therefore, that one can do for a fever patient is to aid the progress of the disease, to watch the state of the organs specially liable to give way in the particular case, and to avoid the complication if possible, and by proper dieting to maintain the patient's strength for fighting out the disease.

The general treatment of fever appears thus to be easily understood and not difficult to carry out. In fact it comes to be a matter rather of nursing than of medicine giving. To a great many people such treatment is too simple. The doctor walks in daily, carefully looks at his patient, asks a few questions, gives some instructions about food—perhaps orders a dose of simple opening medicine—and goes. Some people regard this as trifling. They are not satisfied if they have not the accustomed "bottle" to administer in frequent spoonfuls. The treatment is not heroic enough unless several mixtures of various kinds and colours accompany the progress of the fever. If the doctor does not "come up" to their expectations in this respect, they busy themselves wondering at it, discuss the matter with their friends, perhaps, and as often as not convince themselves of the necessity of making up for the doctor's omissions by administering, unknown to him, some remedy they think suitable to the case. This, or something like this, is not an uncommon experience. Now everyone in charge of a fever patient ought to remember that the sin to avoid is meddlesomeness. If the patient is kept dry and clean in bed, if small quantities of beef-tea, milk, thin mutton-broth, and similar foods are given frequently, so that within 24 hours sufficient for nourishment has been supplied, if care is taken that water is regularly passed, and the bowels are regularly moved, for which an occasional dose of castor-oil, seidlitz-powder, &c., may be necessary, and if, generally speaking, the patient is carefully and quietly tended, that is the main part of the treatment for a case of fever running an ordinary course.

TABLE OF FEVERS ATTENDED BY RASH.

Name of Fever.	Period of Incubation (Hatching).	Rash appears.	Rash fades.	
Scarlet Fever.	4 to 6 days.	2d day of fever.	5th day of fever.	Scarf-skin begins to peel by 10th day, and continues separating for 4 or 5 weeks after.
Measles.	12 to 14 days.	3d or 4th ,, ,,	7th ,, ,,	
Small-pox.	12 to 14 ,,	3d ,, ,,	Crusts of pox begin to fall about 14th day.	Rash first pimples, then blebs, then the fluid of the blebs becomes matter, and by 14th day has dried into crusts.
Chicken-pox.	13 days.	1st ,, ,,	Crusts begin to fall about 7th day.	Rash of pimples becomes blebs; scabs formed by 6th day.
Typhoid Fever (Enteric Fever).	Uncertain. In some cases 21 days.	7th or 8th ,, ,,	Comes out in crops, till end of 3d week.	Fever gradually passes away after 21 days, but is often prolonged by complications, &c.
Typhus Fever.	5 to 12 days.	5th to 7th ,, ,,	Beginning of 3d week.	Fever lasts 14 days. Crisis in 3d week.
Dandy-fever (Dengue).	5 to 6 days.	3d ,, ,,	5th or 6th day of fever.	Second attack of fever and rash follows first after two or three days, lasts shorter time.

Scarlet Fever (Plate VI.) is extremely infectious, very common among children, and often more dangerous because of its consequences than on account of the actual fever.

The **symptoms** of an ordinary case are that the person complains of shivering, weariness, headache and sickness, and *sore throat.* In children a convulsive fit, instead of shivering, not seldom begins the illness. There is great heat and dryness of the skin, and frequently the dulness and drowsiness of the patient are quite marked. Some amount of delirium is frequently present. There is thirst but no desire for food. The pulse is very fast. The appearance of the tongue is peculiar. It is thinly coated with a white fur, but is red at the edges and tip, and numerous minute red points are seen standing out, giving an appearance indicated by the phrase—"strawberry tongue," or "raspberry tongue." This is specially seen on the fourth or fifth day of the fever. The sides of the jaws are slightly swollen, stiff, and sore. On the *second* day of the fever the rash comes out. It comes out in fine red points so numerous and grouped so closely that the skin appears red all over. Appearing first on the face, sides of the neck, and breast, it is soon spread all over the body. It is most intense by the fourth day, and begins to fade on the fifth, disappearing before the end of the seventh. The intense redness of the skin may be shown by contrast, by drawing the point of the finger firmly over it. A white mark is produced, to which the redness quickly returns. The soreness of the throat may be felt a day or two before the fever—it increases up to the time of the rash appearing—the tonsils (p. 136) being very red and swollen, and in ordinary cases it diminishes when the eruption reaches its height. With the fading of the rash the pulse becomes less quick, the fever lessens, and all the symptoms improve, and in the course of a few days the fever and its attendant quick pulse, &c., has departed.

With the disappearance of the rash another peculiarity of the disease presents itself, namely, desquamation or shedding of the skin. The scarf-skin begins to separate in fine or large scales, or in large flakes. It begins on the neck and chest, spreads to the other parts of the body, and to the hands and feet last. Sometimes the scarf-skin of the hand will separate all together as a glove, or that of the foot like a slipper. It usually peels off in large pieces. This shedding of the skin lasts a considerable time. As a rule it is complete by the *sixth* week from the beginning of the fever, but it may end much sooner.

Now the chief elements in these symptoms are the sore throat, the scarlet rash, and the shedding of the skin.

While the above statement gives the symptoms and course of an ordinary fully-developed attack of scarlet fever, there are some varieties.

The attack may be mild, exhibiting the main symptoms but in a very slight degree, and often after the first day or two the patient is so little affected that he or she seriously objects to the confinement. It is to this form the term **scarlatina** is applied. It means merely a mild attack of scarlet fever. Practically, however, *the mild attacks are often found to be more serious than the severer form* just described. *Scarlatina is capable, by infection, of communicating the worst type of the disease, causing rapid death.* Moreover, the evil consequences, so common in the disease, as readily attend the mild as the

severe form. In a mild case it is often difficult to impress the patient, or, in the case of a child, its parents or nurse, with a due sense of the risks. Less care is exercised, there is improper exposure, and dropsy or other symptoms of kidney disease speedily appear. *The mildest case of scarlatina ought to be treated with the same watchful care as the most severe.* There are even milder cases of scarlet fever than those noted. A child is feverish and unwell for a day or two, and apparently becomes quite well, though unusually pale and not strong. No rash has appeared, or at least has been noticed. But, in a week or ten days after, the glands at the side of the jaws swell, the ears become sore, perhaps the skin peels, or other symptoms lead to the conclusion that the child has suffered from scarlet fever.

Again there is a malignant form of the disease, in which there are great brain disturbance, convulsions, and low muttering delirium. The tongue is dry, the throat dark-red, ulcerated, and sloughing. The rash comes out late, and speedily disappears. Death may occur before the rash has time to appear.

Scarlet fever occurring at or immediately after childbirth assumes very fatal characters. It is a form of puerperal fever.

The **results** of scarlet fever are many. Abscesses may form in the throat or in the glands at the sides of the jaw; suppuration may occur in the nostrils and in the eustachian tube (p. 356) leading to the ear. Disease of the ear, accompanied by discharge and ending in deafness, is common. Various affections of the membrane surrounding the heart (pericardium, p. 238) and lung (pleura, p. 266) may arise. Rheumatism is apt to follow. The chief result is inflammation of the kidneys (p. 295), attended by dropsy and albumen in the urine. Inflammations of the eyes are not infrequent.

The **infection** of scarlet fever is undoubtedly at its worst during the shedding of the skin, but not at this period only. It is very probable that the sore throat is also infectious, and that therefore the disease is "catching" from its commencement to its termination.

Treatment.—*Disinfection should be practised from the beginning in the manner* advised on p. 396. At the beginning of the disease nothing is more valuable than a warm bath, which the patient should remain in for from 20 minutes to half an hour. Before the bath a double-strong seidlitz-powder should be given, to children one or two tea-spoonfuls of citrate of magnesia or a dose of castor-oil. Failing the bath, the person should be wrapped, naked, in a blanket wrung out of warm water and rolled in warm dry blankets. After an hour or more the wet things may be removed and dry warm clothes put in their place. The patient should be kept strictly to bed in a well-ventilated room, in which a fire is kept burning. If the fever runs high the wet pack *with cold water* may be repeatedly used if soothing to the patient. For food, milk, beef-tea, strained mutton-broth, switched eggs, and such articles are allowed. To encourage the action of the skin and kidneys the ammonia and ether mixture (PRESCRIPTIONS — FEVER MIXTURES) is valuable. Inhaling the steam of boiling water or sipping warm milk relieves the throat. A warm application over the throat may also be used if the pain is severe. Sometimes nothing is so soothing as allowing a piece of ice to melt in the mouth, and with children giving a tea-spoonful of iced milk or water now and again. If the fever runs high, quinine is the best remedy, of which one grain for every two years of age is given, and repeated every six hours as required. For adults the dose is 5 or 10 grains. When the fever has departed, strengthening food is necessary, and iron and quinine tonics. Daily during the progress of the case, including the period of fever, sponging the body with lukewarm water containing some vinegar is very relieving. The whole body need not be done at once, but by two bathings each day. When the skin begins to separate the body should be rubbed all over with carbolic or camphorated oil. This prevents the scales of the skin being scattered through the air, and diminishes the risk of infection. This should be repeated daily till all the skin has separated. The patient should not be permitted to leave his room or mix with others till all the skin has been shed, and then only after proper disinfection, as recommended on pp. 395, 396.

Grave cases, and cases of kidney disease, &c., must be in the care of a physician. Discharge from the ear should, from the very first appearance of it, be treated as advised for that affection on p. 398.

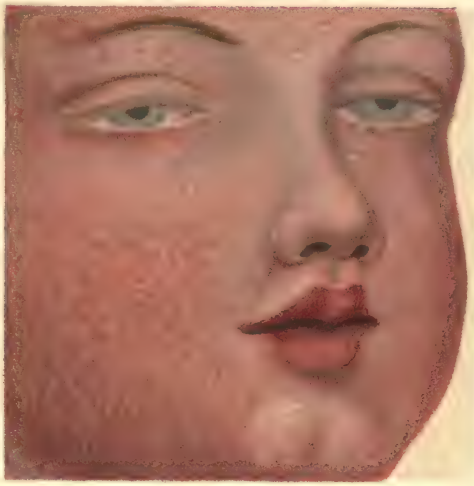
Measles (*Morbilli—Rubeola,* Plate VI.) is an infectious disease occurring most commonly among children, not because grown-up people are less liable to be attacked, but because most people have it in childhood, and one attack protects, as a rule, against another. This is not a rule, however, that has no exceptions; for many cases have been observed of persons attacked for the second time, though that is not common.

ERUPTIVE FEVERS.

THE APPEARANCE OF THE RASH.

Plate VI.

Measles. p 4[illegible]



Scarlatina or Scarlet Fever. p 399

Vesicle of Vaccination on 9^{th} or 10^{th} day, with slight Rose Rash around it p 40[illegible]

Typhus in early stage [illegible] day, ordinary case p 410

Typhus in advanced stage 13^{th} day - Spotted Typhus p 410.

Typhoid, Enteric or Gastric Fever, about 16^{th} day Rose Rash of Typhoid p 413

The **cause** of the disease is, without exception, contagion; that is to say, a special kind of poisonous material is thrown off from the body of a person suffering from measles, which, gaining entrance to the body of a healthy person, gives rise to a new case of the disease. It can never arise anew. The measles germs or seeds must be sown before a crop of measles can arise. Measles thus spreads, like scarlet fever, from person to person, one case being capable of infecting any number of others. It clings to clothing, and to other surfaces. Many people forget this. They visit those sick of the disease without fear for themselves, because they have had it before, forgetting the risk they run of carrying away with them seeds of the disease, to infect others with whom they come in contact. Parents too often forget it when they send their children out to play, or back to school, a sufficient time after their recovery, but without previously disinfecting their clothing. It is for such reasons that, when one of a family is sick of measles, the others, if they are living in the same house, should be kept at home, not only from school but from playing with neighbours' children, lest they spread the fever. It would appear that one who has suffered from measles is scarcely free of the power of imparting the disease till about the end of a month. Of course the infection may cling to rooms and clothing, that have not been disinfected, for a much longer time. Measles is infectious almost from the beginning, at least it is infectious even before the rash has appeared, and therefore, even before the real nature of the affection is quite certain. A patient may, thus, have already imparted the disease to others before it could be known that he was himself suffering from it. This is different from scarlet fever, in which the chief period of infection is while the scarf-skin is separating—the period of desquamation, as it is called.

Symptoms do not show themselves till from twelve to fourteen days after infection. The attack begins with signs resembling those of cold-in-the-head (catarrh, p. 154). There are chills or shivering fits, in children sometimes convulsions, followed by evident fever. The appetite is lost, the tongue white, and there may be vomiting. Cough is present, generally of a harsh barking character. There is sneezing, the eyes are red and watery and sensitive to light, and the head aches. These symptoms increase up to the fourth day, when the rash begins to appear, at first on the forehead and temples, at the edge of the hair, and then on the cheeks, chin, and neck. It then extends downwards over chest, arms, belly, and legs. On the fourth day the fever seems to be at its height. It may reach 104° Fahrenheit (see p.10), accompanied by rapid pulse and sometimes delirium. The rash consists of well-marked, red, roundish spots, *raised above the skin.* Appearing first here and there, they quickly form groups, which run together into irregular patches. When they are numerous the skin is swollen. The face is thus very red, and irregularly swollen and rough, when the rash is well out. The spots being raised above the surface, the skin feels very rough, and so measles is easily distinguished from scarlet fever, in which there are no raised spots but only a general redness. If the rash is well 'out' by the fourth day, then on the fifth the fever usually is much diminished, the cough is softer, and the pulse less rapid. Within two days of its appearance the rash begins to fade, disappearing from the different parts in the order in which it came, but leaving a mottling of the skin, of a dusky colour, which does not completely fade for ten days or longer. Very fine scales separate from the skin, of the face and neck in particular, on the disappearance of the rash. In ordinary cases, without complications, the fever has almost if not quite passed away by the seventh day, leaving the patient weak.

It is very common for the cough to be the first thing to attract special attention. A child, who has been restless and irritable during the day, rouses its parents in the night by a hoarse barking cough, which immediately suggests croup to their minds. It has not the metallic, brassy ring of croup, however, for which it may be mistaken till, in one or two days, out comes the measles rash, showing the true nature of the illness.

Measles is not the very simple disease that many people seem to imagine. Bronchitis is a very common complication, maintaining the high fever beyond the sixth or seventh day, delaying recovery, or causing death. In young children the attack of the disease with the accompanying affection of the chest may be so severe as to cause death before the rash has time to appear. In hot weather an attack of diarrhœa is serious, and in hot climates dysentery is not an infrequent bad attendant of the attack. In cases of children with not robust constitutions, measles is apt to leave very weakened conditions of general health. Serious inflammation and ulceration of the eyes, discharges from the ears, and swellings of glands often

follow an attack of measles in unhealthy children, and are very difficult of cure.

Persons may suffer from measles and mumps or whooping-cough at the same time.

Treatment.—From the very beginning of the disease, before the suspicion of its nature has time to be confirmed or otherwise, the patient should be separated from others, and steps should be taken for disinfection, as described on p. 395. The person must be kept quiet in bed in a room kept at a regular degree of warmth, but yet with plenty of pure air. Draughts and chills should be carefully avoided. Bread and milk, beef-tea, mutton broth, and such mild food ought to form the diet. If the fever is high and the patient restless, a warm bath is of great service, or sponging with lukewarm water. The cough may be relieved by gargling the throat with warm milk. Sometimes sucking a small piece of ice is very grateful, but much improvement need not be expected till the fever begins to diminish. To aid in promoting the action of the skin and kidneys the following mixture is valuable:—

Solution of the Acetate of Ammonia, ...	1½	ounce.
Spirit of Nitrous Ether, ...	½	,,
Ipecacuanha Wine, ...	¼	,,
Mucilage (Solution of Gum Arabic), ...	1	,,
Water, ...	1	,,

Give from a half to one tea-spoonful (according to age) every two or three hours.

This is specially useful at the height of the fever. If convulsions occur, a warm bath should be employed.

As recovery takes place the food should gradually return to the full ordinary diet. After the disappearance of the fever, if exhaustion is great, small quantities of port wine are necessary, but not otherwise. A dose of mild opening medicine is occasionally necessary, but is to be carefully given, from the risk of looseness of the bowels.

Affections of the ears and eyes are to be treated as recommended in Section XII. B.

German Measles (*False Measles*, *Rötheln*, *Rubella*, *Epidemic Roseola*) is a disease apt to be mistaken for measles, and even scarlet fever. It differs from measles in there being little sneezing, little cough, and nothing of the red watery eyes, all of which are characteristic signs of measles. It is a different disease from measles, for, while one attack of measles protects, as a rule, from a second, an attack of false measles gives no protection from true measles, though it protects against a second attack of its own kind. It never develops into true measles, though a child may have a real attack of measles shortly after an attack of German measles. It is not so contagious as true measles. The affection does not show itself till from one to two weeks after infection.

Symptoms.—The disease is marked by an eruption, appearing first on the face and quickly spreading over forearm and hands, legs and feet, and rapidly covering the whole body. The spots are *raised above the skin*, of a dusky red, irregular in shape, and they soon run together. This eruption is accompanied by little fever. The patient may complain of a feeling of fulness of the head, of giddiness, and perhaps of some headache, in short of being a little "out of sorts," and frequently does not complain at all, the rash being attended by apparently no disturbance. Moreover, before the eruption there is often little complaint. In true measles, as noted on p. 401, there is considerable fever, with severe cough, sneezing, and other signs of cold-in-the-head, and the fever usually reaches its height when the rash appears on *the fourth day*. Now, in false measles, if there is any disturbance before the fever it is slight, and usually the rash appears *within one day, or at the most two days*, of the person feeling unwell. It does, however, sometimes happen that there is considerable fever, loss of appetite, &c., before and during the rash, and in young children the disease occasionally sets in with vomiting, diarrhœa, and convulsions. On the second day the rash is fully out, and immediately begins to disappear, fading by the third or fourth day. It is accompanied by itching, but on fading it leaves no mottling of the skin as measles, though the separation of fine scales of the scarf-skin may follow it.

Treatment.—Rest in bed for three or four days, and such mild diet as recommended for measles are sufficient treatment. The infectious character of the disease must not be forgotten, and as the infection probably lasts for some weeks, care should be taken that the disease is not spread.

Small-pox is a contagious and infectious disease. Its chief feature is the appearance of a rash on the skin, consisting first of pimples, which enlarge and become little sacs filled with clear fluid, afterwards changing into matter. Scabs form when the matter dries up, and on their fall, they leave marks or not according to the severity of the attack. There are different degrees of severity of an attack of small-pox, in-

dicated by the eruption. In the less serious form the different pocks are separate from one another, and the small-pox is said to be *distinct* or *discrete*, in a more violent form the pocks run together, and the disease is said to be *confluent*. The former kind is often fatal, the latter nearly always so. The disease, like other contagious fevers, has a period of incubation, there is, that is to say, an interval between the time when the disease is caught and the time when it begins to show itself. That period is from eight to eleven days. In all cases several stages can be recognized in the progress of the fever. These stages are—that of *invasion*, the period of the beginning of the attack, that of *eruption*, the period when the rash appears, that of *suppuration*, the period during which the contents of the pocks become matter, and that of *drying-up* or *desiccation*, when crusts form. The time of these stages may be given. As a rule the fever begins *eight or twelve days after* the disease is "caught;" *on the third day* of the fever the eruption appears; *about the eighth day* suppuration begins, and lasts till the eleventh, after which the drying-up process goes on; the scabs tend to separate *about the fifteenth*, *eighteenth*, *or twentieth day*. These are the times for the appearance, suppuration, and drying-up of the eruption *on the face*. On other parts of the body the various stages are a little later in occurrence.

Symptoms of Distinct Small-pox.—The chief symptoms at the beginning of this form are fever and constant sweating, vomiting and costiveness of the bowels, and severe pain in the small of the back.

The attack is usually sudden. The patient is seized with shivering fits (rigors) followed by great heat of the skin. The sweating is marked for several days in grown-up persons, not in children. In children also diarrhœa (looseness of the bowels) is usual and not costiveness, but in adults diarrhœa is rather the indication of a very severe attack. Convulsions are also common in children. The pain in the back is usually severe, and may be attended by numbness or paralysis of the legs and difficulty in making water. Instead of the severe pain in the small of the back, there may be dull pains throughout the body like those of rheumatism. During this time the fever runs high.

With the beginning of the *second stage*—the appearance of the eruption — the fever falls and the other symptoms disappear, so that the patient may seem to be almost well. This continues till about the eighth day, when the fever returns with the suppuration of the pocks. The eruption, as it appears on the third day, consists of small red hard points, slightly raised above the skin. They grow larger, and in the course of a day form hard prominent pimples. In the course of two more days they have become converted into vesicles, that is, small sacs or blebs containing a milk-like fluid. They go on increasing in size. On the eighth day the fluid they contain has become yellowish, and consists of matter or pus. Hence the eruption consists now of pustules, or small abscesses. On this day, also, the skin around each pock or pustule is distinctly red. There is, indeed, a ring of inflammation round each. Accompanying the inflammation there is swelling in the skin and parts beneath it. The pustules are painful and the fever returns.

The return of the fever marks the arrival of the *third stage*, that of suppuration. The pustules still increase in size, and the yellowness of their contents becomes more visible. This stage is marked also by swelling, already noted, of the parts on which the eruption is seated, which increases up to the *ninth day* of the disease, and then diminishes, disappearing about the eleventh day. It is greatest where the skin is loose, and thus is often very great on the eyelids, causing complete closure of the eyes. It is marked on the hands and feet. The fever of the period of suppuration may not be so high as the early fever. It is accompanied by shiverings, quick pulse, loss of appetite, furred tongue, and delirium. It lasts for three days, and then if the case progresses favourably, rapidly disappears, not to return, and the other symptoms with it. The pustules thereafter pass through the process of drying-up, to be noticed immediately.

The eruption does not appear all over the body at once. It begins on the face and neck, spreads to the upper part of the chest, arms, and hands, to the rest of the body later, and to the legs last. In the course of two days it will have spread over the body. But those on the face having appeared first, will always be in advance of the others, and thus those on the face may be dried up while those on the legs are only fully ripe. The eruption is also present on the lining membrane of the throat and mouth, and causes pain in the throat, felt from the commencement of the rash. It is also sometimes present on the lining membrane of the eyelids (the conjunctiva, p. 339), and may lead to serious injury of the eyes. The pocks on the body have often a depression in the centre, not seen in those on the face. Pocks showing this are said to be umbilicated.

The *final stage* of small-pox is that in which the pustules dry and form scabs. The scabs begin to fall from the face between the fifteenth and twentieth days, and a little later from the body. A red prominence is left, after the fall of the scab, on which scales form, and from which they fall for, it may be, several weeks. Finally after some months the redness disappears, and a white scar is left, below the level of the rest of the skin. If the pocks have not been large, the marks may be very slight.

Such is the history of **distinct small-pox.** It is one of the least fatal forms of the disease, except in unvaccinated children below one year of age. Nevertheless it may prove fatal even in grown-up persons. When death occurs from distinct small-pox, it happens about the eighth or ninth day. According to the French physician, Trousseau, a fatal issue is to be feared when the eruption does not come well out by the fifth, sixth, or seventh day, when the pustules are irregularly formed, when the sweating ceases suddenly and cannot be recalled, and when delirium occurs with dry cold skin and a weak, sharp, irregular pulse. Profound unconsciousness and twitchings of the tendons are signs of approaching death.

Symptoms of Confluent Small-pox.—The confluent form of the disease, in which the pocks run together, is a very fatal form. The symptoms of its commencement are similar to, but more severe than, those already described. The pains are more intense, fever more decided, and vomiting continuous. The eruption comes out earlier than in the ordinary case, appearing on the second day instead of the third, though in very bad cases the rash may be delayed. The fever is not only very high, but it does not fall for any time between the period of the rash appearing and the period of the pocks ripening, as it does in distinct small-pox. It is almost continuous till the pustules have become yellow with matter. The eruption, which, as already stated, appears early, and may at first be mistaken for measles, because of the general redness of the face, consists of small pimples extremely close set. As they grow in size great swelling of the face is produced, and when they grow into blebs, they so run together that large patches of raised skin are produced like that caused by a blister. The swelling of the face is accompanied by swollen eyelids, swollen jaws and ears, and there are constant flow of water (saliva) from the mouth, and harsh cough. The ball of the eye may be fiercely attacked and vision destroyed. The swelling of the face and the flow from the mouth should begin to diminish by the eleventh day. At the same time there occurs great swelling of the hands and feet, due to the pustules, and the swelling is accompanied by pain. When the pustules have become ripe, full of matter, which occurs between the eleventh and thirteenth day, they give out a most disgusting stench, and the patient's skin is in a most serious condition, with the leaking pustules, ulcers formed from them, and often boils and abscesses, due to some extent to the irritation of the decomposing matter of the pocks. (Plate VII.).

Delirium, in confluent small-pox, is apt to continue from the fifth day of the disease till the thirteenth or fourteenth day, when it should cease. But the fever has not such a defined period, for it may be maintained beyond the third week by the formation of boils and abscesses in the skin, and also in deeper parts. At this late period attacks of shivering, with high fever, indicate the formation of deep boils.

In confluent cases death is very common, and usually occurs between the eleventh and fourteenth days. Excessive delirium, or deep unconsciousness, great prostration, much difficulty of breathing, and anxiety, these are all bad signs. Death sometimes arises from suffocation by swelling and the formation of membranes in the throat. Inflammation of the lungs may hasten a fatal termination. But even should the patient survive this period, prostration and death are too apt to be the result of the prolonged formation of boils, &c., in the skin and deeper parts.

Black Small-pox is the most fatal form, and is so called, because, while the ordinary rash is scanty there is an eruption of dark blue, violet, or black spots. These are due to bleeding that has taken place into the skin, and in some cases blood is lost from the nose, mouth, and other parts. Such cases are accompanied by delirium and high fever and rapidly end in death.

Treatment.—As in other fevers with rash, no attempt need be made to arrest or cure an attack of small-pox. It will run its own course. All that remains for friends or doctor to do is to "stand by," and do all that is possible for the patient's comfort and for the maintenance of his strength. The patient should be placed in a large well-ventilated room. The patient must not be heavily covered. His body and his bed should be kept as clean as possible, sponging with lukewarm water may be adopted, and the bed-sheets should frequently be changed. The skin may be anointed, after sponging, with

olive-oil or vaseline. Mutton broth, milk, beef-tea, &c., should be given in small quantities frequently. Lemonade, or gingerade, or acid drinks made with dilute sulphuric acid, are grateful. If delirium and excitement are great, lukewarm baths are of use. The attendants should have been vaccinated. A patient who recovers must not be allowed to mix with other persons till all crusts and scales have disappeared, and till daily baths for a week have been taken. The utmost care must be taken to prevent the spread of the disease, as advised on p. 395. During a small-pox epidemic all unvaccinated persons should be vaccinated, and among those who have been vaccinated, but as long before as seven years, re-vaccination should be practised.

Small-pox as altered by Vaccination (*Modified Small-pox—Horn-pox*).—While vaccination, if properly performed, as a general rule protects from small-pox, yet a vaccinated person may take the disease; but it does not run the ordinary course, and the risk attending it is slight. In the same way a person who has had small-pox is protected, as a general rule, from a second attack. Yet cases do occur where the disease attacks for the second time, and in this case also it does not run its full course. In both cases the disease is altered. It is, nevertheless, the same disease, for if a person suffering from the altered form communicates the disease to an unvaccinated person, in that person it will appear in its ordinary unaltered form. A vaccinated person suffering from a mild attack of small-pox may thus communicate the disease in its most aggravated form to an unvaccinated person. (Eruption is shown on Plate VII.)

The **symptoms** of altered small-pox are up to a certain point similar to those described under distinct small-pox. The symptoms at the beginning are the same—shivering, fever, pains in the back, vomiting—but they are milder. The eruption comes out about the same time—the third or fourth day—but the pimples are few in number. They suddenly cease to progress in the usual way, and soon disappear. Or the eruption comes out as usual, progresses to the stage of forming blebs, and then dries up without any fever of suppuration. Even when the pocks reach a more advanced stage, swelling of the face, of the hands and feet, and other symptoms of the bad forms of small-pox are scarcely ever seen in small-pox altered by vaccination. In short the disease never gets a proper hold of the person. It may flourish for a few days, but speedily looses its hold and convalescence begins. Just as some seeds sown in particular kinds of soil may never produce good fruit, because the soil is deficient in the particular kind of nourishment they need, so that they spring up and progress to a certain stage only to wither away, so, in a person who has had small-pox previously or has been vaccinated, there seems to be a want of the particular elements in the blood and body on which the small-pox poison flourishes. They either are, on that account, unable to take a second attack, or, if they take it, the disease advances only a little way and then abruptly terminates.

Inoculated Small-pox.—Long before vaccination was known it had been observed that persons who were inoculated with small-pox, into whose skin, that is to say, the small-pox poison was deliberately inserted, suffered usually from a milder form of the disease than those who caught the infection in the ordinary way, while at the same time they were protected from another attack. It appears that the habit of inoculating small-pox was practised from time immemorial in Persia and China, just because small-pox was so common that few could escape it, and because the attack was less likely to be fatal when deliberately communicated in this way. An English lady, Lady Mary Wortley Montague, observed the practice while residing in Constantinople in 1717, and had her son of six years of age inoculated with success. Returning to England she announced the practice in 1721, and had it performed with good result upon her daughter. As a result the practice spread, but met with much opposition. But after a time it was accepted, and generally performed till vaccination was introduced.

On the second day after matter from a small-pox pustule has been introduced under the skin of a person, a pimple appears at the spot. By the fourth day it has become a bleb, and by the seventh or eighth the milky fluid in the bleb has become matter, that is, the bleb has become a pustule. It is surrounded by a red inflamed ring, which increases up to the tenth day, and on which a number of smaller pustules appear, round the large one, which also increases in size. It is not till this time that any signs of general disturbance appear. But now shiverings occur, fever arises, headache and pains in the loins are felt, and there is vomiting—the usual signs of the beginning of an attack of small-pox. On the eleventh, twelfth, or thirteenth day after the

inoculation the ordinary small-pox rash appears, which follows the course described under **distinct small-pox.**

Small-pox so produced is infectious, and an inoculated person might, therefore, originate an epidemic. Moreover, though usually mild, it was sometimes disfiguring and fatal. One can, then, understand how, at one time, the disease was feared and dreaded, when persons would run the risk of being inoculated rather than take the chance of escaping infection in the ordinary way. This is one of many facts of which the agitators, who denounce vaccination, are surely ignorant.

Vaccination (from Latin, *vacca*, a cow. *Cow-pox*). (Plate VI.) In spite of inoculation, practised as described in the preceding paragraphs, the mortality from small-pox seemed to be on the increase in Britain, when, in 1798, Edward Jenner, a surgeon practising in Gloucestershire, published an inquiry into the causes and effects of cow-pow.

Cow-pox is a disease of oxen, manifested by the appearance, usually on the teats and udders of cows, of pocks, which almost exactly resemble those of small-pox. There is also a disease of the horse, called **horse-pox,** supposed to be the same disease to which the term **grease** is applied, which is believed to be the same disease as cow-pox. Cow-pox is a contagious disease, and is liable to break out as an epidemic among cattle. Now, anyone who milks a cow, suffering from this disease, is liable to get on the hands some of the matter from the pocks, and if by a scratch or other pathway the matter can pass into the system of the person, that person is likely to contract the disease, which will show itself by the appearance of pocks at the infected parts, but by no other symptoms of any consequence. It had been for long a tradition among dairy-folks that anyone who had thus contracted cow-pox was safe from the risk of an attack of small-pox. This notion Edward Jenner had become aware of while still an apprentice to a surgeon, and it took firm hold of his mind. For years he did not cease to think of it, to inquire concerning its truth, to make observations and experiments as well. For thirty years he worked quietly at the subject, and then he published his work on cow-pox, which completely established the truth of the old and vague idea, and raised it at once to the rank of a scientific fact. He gave details of persons who had accidentally contracted cow-pox, and who had remained proof against the infection of small-pox. He showed that persons who had thus been accidentally vaccinated were safe from small-pox even when small-pox matter was deliberately introduced into their bodies. He did more. He took matter from the pocks of a cow and introduced it into the skin of a child. In time this child showed the pocks of vaccination, now so familiar to every one. With matter from this child he vaccinated a second, and with matter from the second he vaccinated a third, and so on through five generations. Then into the body of the child vaccinated last *he introduced small-pox poison and found it proof against the disease.* This was convincing evidence that the matter of the cow-pox could still protect from small-pox even after it had passed through the systems of many persons in succession. It was not, therefore, necessary to go back to the cow for matter. After the publication of Jenner's work his statements were subjected to tests of the utmost severity, and were found to be perfectly unassailable. Thus at the London Small-pox Hospital, in the two years following that of Jenner's publication, 7500 persons were vaccinated, and about one half were afterwards inoculated with small-pox poison without the slightest effect.

Course of the Vaccination Pocks.—When a person has been properly vaccinated, nothing appears where the matter has been inserted till the second or third day, when a small red pimple shows itself. This grows larger and becomes, by the fifth or sixth day, a rounded greyish bleb filled with clear fluid, and usually not raised in the centre. It goes on becoming larger till the eighth day. After this the clear contents begin to become yellowish, the skin round the pock becomes red, inflamed, and thickened, and by the tenth day the skin for some distance round the pock is deeply red and hard, and the contents of the pock have become yellow matter. The pock now begins to dry up, and the inflammation and hardening round about to lessen, till by the fourteenth or fifteenth day the pock has changed to a dry dark scab, which falls about the twentieth day or a few days later, leaving a scar in the skin presenting numerous little pits, the surrounding inflammation having disappeared. If the vaccination has been successful the scar remains for life, and is easily recognized. A scar not well marked means imperfect vaccination; and, of course, the degree of safety from small-pox varies with the degree of effect which the vaccination matter has produced in the body of the person. During the progress of the pocks the person exhibits

signs of being generally affected, but not, as a rule, before the eighth day. There is some degree of feverishness, restlessness, irritability, and disturbance of digestion, which soon pass off, but still indicate that the vaccination has produced more effect than simply a pustule at the place where the matter was inserted. If the pocks do not pass through the stages described, if, for example, a scab is formed on the fifth or sixth day which soon falls, the vaccination is not perfect and the protection is not complete.

Now the same pocks are produced whether the matter has been taken direct from the cow or from a person previously vaccinated.

The matter intended for vaccination should be taken from the cow or from the human being *on the eighth day*, while it is still clear and transparent.

Mode of Vaccination.—One of the most valuable parts of Jenner's work was the proof that the matter of the cow-pox could be passed through human beings for many generations without its value being lessened. From each fully grown pock sufficient matter can be obtained to vaccinate about a dozen persons. When the pock is opened by the fine point of a clean lancet, the clear fluid runs out, and this fluid may be placed on the skin of an unvaccinated person from the lancet point, and caused to enter the blood by the point being passed into the skin sufficiently deeply to reach the true skin. A simple method consists in making a series of scratches across one another (as in Fig. 181), with the clean lancet point, on the part of the skin where the matter is placed. The scratches should be just deep enough to show blood. If they are too deep, the flow of blood may wash the matter away. The upper part of the arm is usually chosen. The matter may be kept for any length of time in properly sealed tubes. Extremely fine hair-like tubes are used. When the end of the tube is placed in a drop of the fluid, the matter passes up by attraction, and when the tube is thus three-parts filled, the ends are sealed in a flame. Or the matter may be placed on small slips of glass or on clean quill points and allowed to dry. When the matter is required for use, the ends of the tube are broken off and it is blown out on to the skin, or the plates or quills are moistened with a small drop of pure water and rubbed on the skin where the scratches are made. Thus from one good pock sufficient matter may be preserved to vaccinate half-a-dozen or a dozen persons.

Fig. 181.

Objections to Vaccination.—It might have been supposed that when Jenner had conclusively shown the value of his practice, and when cases by the thousand and tens of thousand confirmed his views, and proved that by means of vaccination a hateful disease, which killed thousands annually and mutilated for life many thousands more, could be rendered practically harmless, it might have been supposed that the acceptance of the practice would have been universal. But it was not so. Objectors rose on every side, and the more successful the method was shown to be the more vigorous became the opposition. One set of objections was sentimental. It was maintained that with the cow-pox some of the disposition of the ox would be imparted. It was declared that the moral character of children became perverted, that they exhibited the effects of a "bestial humour," that as vaccination was carried on the human race would degenerate, that innumerable evils would arise, that innumerable new and unheard-of diseases would appear, that brutal tendencies would appear in vaccinated children, and that even brutal features would show themselves, in the appearance of horns, hair, perhaps tails, in the expression of the voice, which would become bellowing, in the character, which would become bullying. Pamphlets and doggerel rhymes of the wildest description were published to throw discredit on the practice. The following verses from one of these sufficiently show the nature of this opposition:—

O Jenner! thy book nightly phantasies rousing,
Full oft makes me quake for my heart's dearest treasure;
For fancy, in dreams, oft presents them all browsing
On commons, just like little Nebuchadnezzar.

There, nibbling at thistle, stand John, Jem, and Mary,
On their foreheads, O horrible! crumpled horns bud;
There Tom with his tail, and William all hairy,
Reclined in a corner are chewing the cud.

Another kind of objection was of the pious sort. Small-pox was a "merciful provision on the part of Providence to lessen the burthen of a poor man's family;" it was impious to attempt to set aside a divine dispensation; &c., &c.

There were other and more serious objections. It was urged, and proofs were offered in support of the statement, that vaccination did not give the protection asserted, that many vaccinated persons were seized with small-pox, that vaccination so affected the system as to lay it open to such diseases as consumption, scrofula, &c., and that, with the vaccine matter, the poison of such diseases as syphilis might be and was introduced. The result of these more scientific

objections was to rouse the supporters of vaccination to the fullest and most far-reaching inquiries. Medical colleges and medical men were appealed to in every civilized nation, and as a consequence a body of evidence in favour of vaccination was produced, which to this day stands unassailed and unassailable, fitted to convince every rational mind that vaccination, *if properly and universally employed*, affords a method of completely stamping out small-pox from the face of the earth. Anyone who chooses to examine the question for himself will find the facts in "Papers Relating to the History and Practice of Vaccination," presented to the British House of Commons, and published in 1857. Some of the most striking facts may be given. It is estimated that in 100 years before the introduction of vaccination, 45 millions of persons died in Europe of small-pox. In Greenland in 1734 two-thirds of the population were swept away by an epidemic. In Iceland in 1707 it destroyed 18,000 out of a population of about 50,000. In North America one tribe of Indians, numbering 1500 persons, all perished by its ravages excepting only thirty. It is estimated that in the Russian empire alone it had *annually* two millions of victims. After the introduction of vaccination the death-rate from small-pox fell at once, and diminished just in proportion to the thoroughness and extent of the practice. In Sweden, before its introduction, small-pox had annually 2050 victims, after its introduction only 158; in Berlin for 24 years before its introduction the deaths from small-pox were 3422 annually, for 40 years after its introduction the annual death-rate fell to 176; in London the annual deaths from small-pox before vaccination were 3000 to 5000, after its introduction they were under 340. It is to be remembered that these results were obtained when vaccination was not nearly universal, and that the deaths were chiefly among non-vaccinated persons.

It appears, however, quite true that the protection from vaccination is not absolute. That is to say, there have been cases where persons properly vaccinated have yet contracted small-pox, but *in every case the disease was so mild as to cause little risk of death.* Such cases are, however, rare. It was abundantly proved that the very large proportion of cases brought forward of persons who had contracted small-pox after vaccination, were really cases in which the vaccination had been improperly performed. It was shown that matter, in no sense true vaccine matter, might be used which would produce irritation at the point of insertion and set up inflammatory changes, which ignorant persons might suppose to be the vaccine pocks, but were not so. Such false vaccination could not give protection. While this was proved, it is admitted that in a few cases, indeed a very few cases, proper vaccination may not completely protect from small-pox, though it renders the disease extremely mild. But then there are undoubted cases on record where one attack of small-pox itself does not confer complete protection from a second. Indeed it would appear that the protective power of efficient vaccination is of the same extent as the protective power of a previous attack of small-pox.

The explanation of the protection accorded by small-pox is one that was surmised by Jenner himself. Numerous positive experiments go to show that the pocks of the cow and the small-pox of man, as well as (apparently) the pocks of the horse, are due to one and the same poison operating with different degrees of violence on different animals. Thus Mr. Ceely, a surgeon of Aylesbury, began a series of experiments in 1839, which went to prove that small-pox poison introduced into the body of a cow produced cow-pox. Thus, in one case, he introduced small-pox poison into a stirk. At the place of puncture the cow-pox appeared by the sixth day. From one pock he took matter with which he vaccinated several children, and in the children it produced the appearance of ordinary vaccination pocks. He passed this matter through several generations in children, and obtained a supply of matter which was used in the Small-pox Hospital and Cow-pox Institution of Dublin, and gave all the results of ordinary vaccination. Thus small-pox of the human being became cow-pox in the cow, and the matter of the cow-pox, when transferred to the human being, became the vaccination-pox. It thus appears that vaccination protects against small-pox because it is, as regards the poison producing it, the same disease, but deprived of its violence and extremely poisonous character by previous passage through the cow. Therein lies the reason why vaccination cannot protect more absolutely against small-pox than small-pox itself.

As tending to show how the objection that vaccination does not give complete protection against small-pox is rather an argument against imperfect vaccination, one or two facts may be given in the form of a table. The table is based on the observation of 5000 cases of small-pox received in the Small-pox Hospital of London. It states the death-rate among different classes

of patients: (1) the unvaccinated, and (2) the vaccinated. But the vaccinated have been divided into different sets according to the number of vaccination marks or scars found on their persons.

Of unvaccinated, there died ...	35	out of every	100
Of those said to be vaccinated but having no mark, there died about	23	,, ,,	100
Of vaccinated—			
Showing 1 mark, there died nearly	8	,, ,,	100
,, 2 marks, ,, ,,	5	,, ,,	100
,, 3 ,, ,, ...	2	,, ,,	100
,, 4 ,, ,, ...	1	,, ,,	200

These figures are confirmed in the experience of other hospitals. It appears thus that the more thorough the vaccination the more complete the protection, and that that amount of vaccination is safest which leaves four well-marked scars.

It has been shown that the protective power of vaccination diminishes after the lapse of years. That objection is easily met. It is only necessary to have the vaccination repeated whenever necessary. (See RE-VACCINATION, p. 410.)

The gravest objection that has been urged against the practice is that vaccination has, in many cases, been the direct cause of serious disease. It is quite true that carelessness and want of cleanliness on the part of parents towards their vaccinated children may result in serious inflammation, erysipelas (rose), &c., of the vaccinated arm. But filthiness will render a pin-scratch a serious affair, and it is monstrous to suppose that parental neglect is to be an objection to a method for protecting the lives, not of one here and there, but of the whole community from a disgusting and fatal disease. Unfortunately there can be no doubt that syphilis has been communicated by vaccination. It has been shown, however, that pure vaccine matter taken from a syphilitic child cannot communicate syphilis to another child. It is only when the vaccine matter *is mixed with the blood* of the diseased child that risk arises. There are, therefore, two safeguards against such a danger, one is the evidence to the eye that the matter about to be used has no trace of mixture with blood, the other is due care in the selection of a healthy child from whom the matter is to be obtained. In short, care on the part of both parent and vaccinator are two absolute safeguards against the possibility of any danger arising from the practice.

But it would require proof of even greater dangers to justify any attempt to set aside a practice which has effectually subdued a disease that has swept away whole populations, and has every now and again made attempts to reassert its old evil dominion. The compulsory adoption of the practice is justified by the fact that every unvaccinated person is a danger to the community in which he lives. If the person who refused to be vaccinated endangered only himself he might be left till time and small-pox taught him his folly, but when it is remembered that every small-pox patient may be a source of infection to multitudes, a community is entitled to decree that no man shall be permitted to dwell in its midst without adopting the recognized precaution against the disease. "The wheel of time brings back the follies of the past oftener than its wisdom," and objections that were met and answered two-thirds of a century ago still find people prepared to urge them. Anyone who carefully examines the many documents on vaccination that are open for reference, can arrive at this conclusion only, that the opposition to vaccination can find supporters only among the grossly ignorant or the wholly irrational.

Rules for Vaccination.—Every child ought to be vaccinated within a very few months after birth. If the child is well and strong it is good to have it done by the third month, before the troubles of teething begin. *If, however, small-pox be in the neighbourhood no age is too early.* If the child be sickly or recovering from some sickness it ought to be postponed for some weeks till strength returns. Not less than two well-marked pocks should be produced, but four give the greatest degree of safety. Many people prefer to have their children vaccinated with matter from the cow, and there is, of course, no objection to this if the child be vigorous. For it is to be noticed that the effects of the cow's matter are more marked than those of matter passed through the human subject. But if the child from whom the matter is taken is thoroughly healthy there is no risk in the use of such matter, and it is as effective for the purpose. The arm which has been vaccinated should be carefully protected from rubbing and injury, and perfect cleanliness observed. Care should be taken that clothes do not press unduly up into the armpit to interfere with the natural flow of blood in the part. Many people employ shields for protecting the parts from rubbing. This can be quite as well done without such a contrivance. Moreover, the tapes used for tying on the shields are seriously apt to interfere with the circulation and cause a much more than usual degree of swelling in the arm. Wherever small-pox is prevailing all persons above ten at the utmost,

who were vaccinated in childhood, should be re-vaccinated, and naturally no time should be lost in having vaccination performed on any who have never undergone the procedure.

Re-vaccination. — It is extremely desirable that all persons who have been vaccinated in childhood should be vaccinated again before the twentieth year as a matter of course, but where any risk of infection is present, the second vaccination should be performed by the tenth year. Small-pox among adults who have been re-vaccinated is practically unknown. But, after the lapse of years, the protection against small-pox to those who have undergone the process only in childhood diminishes, though if they were attacked the disease would always be milder.

Chicken-pox (*Varicella*) has been supposed to be a mild form of small-pox. It is not so, for an attack of small-pox does not protect against chicken-pox, nor the latter against the former, although one attack of chicken-pox protects against a second. It is highly infectious; and children mainly suffer. The infection is caught from one to two weeks before the disease shows itself. That is, its period of incubation or hatching lasts that time.

Symptoms. — The disease shows itself by some degree of feverishness, restlessness, loss of appetite, and within twenty-four hours rosy-red pimples appear on the face, head, chest, and other parts of the body. These speedily become blebs, filled with clear fluid and surrounded by a ring of inflammation, enlarging till they may be equal to the size of a split pea. Within a week the blebs pass through the stage of pustule, that is, the clear fluid becomes changed into yellow matter, and dries up into dark-coloured scabs. By another week the scabs have fallen, leaving red marks, which last for a time. The rash does not come out all at once, but in crops, so that for three or four days one set follows another. They may appear on the sides of the mouth and tongue. In ten days or a fortnight the disease has run its course. The disease has no evil results, though the child may remain weakly for some days after its disappearance. (Eruption is shown on Plate VII.)

Treatment.—The child should be kept in one room, and have ordinary mild diet, milk, &c. No medicine is necessary. Separation from other children ought to be insisted on, as the disease is so infectious.

Typhus Fever is a very infectious fever. The infection seems to come off from a patient in the breath, and not, as in typhoid fever, in the motions from the bowels. The infectious matter, however, does not seem to thrive in the open air, nor does it attach itself to clothing, &c., or retain its poisonous characters as that of scarlet fever does. For free ventilation and plenty of fresh air are not favourable to the spread of typhus. It is probably for this reason that typhus is largely a disease of the poor, especially of the poor crowded together in small, ill-ventilated, and dirty houses. It is specially common in overcrowded parts of the poorer districts of towns in Great Britain and Ireland. It attacks both sexes almost equally, and at all ages, though the majority of those attacked are between the ages of ten and thirty. The greatest number of cases occurs during the winter and the smallest during summer, perhaps because in the winter the very poor huddle together for warmth, and the condition of overcrowding is thus readily produced. It usually attacks the same person only once, although there are cases of the same person suffering from it twice or even thrice.

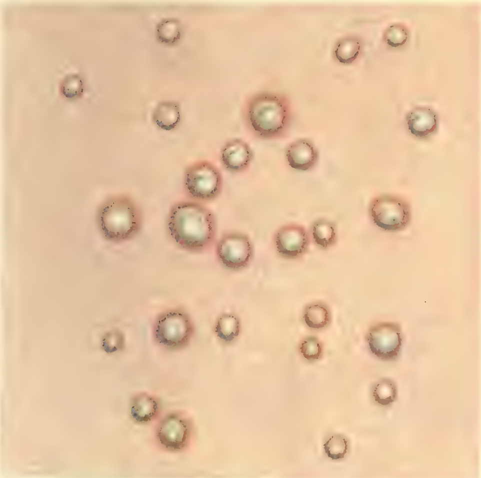
Symptoms.—Between five and twelve days may pass after the person is infected before the symptoms of the disease appear. The first symptoms are shivering, headache, loss of appetite, thirst, and perhaps sickness, general weakness, quick pulse, and increased heat of skin. The bowels are bound. A noticeable symptom is dulness and heaviness of the patient, who has a stupid confused look, and cannot fix his mind upon anything; and sleep is disturbed. About the fifth or seventh day the rash comes out (Plate VI.). It is apt to be mistaken for measles, but the spots, which are of a dusky red colour, are not so large and raised as those of measles. It appears first on the sides of the chest and belly (measles appears first on the forehead round the edge of the hair), and on the hands, wrists, and elbows, spreading over the body, arms, and legs in a couple of days, but not marked on face and neck. After coming fully out it remains out for two or three days, and then begins to fade, disappearing by about the fourteenth day. In bad cases dark-coloured spots, due to the escape of small quantities of blood in the skin, may be present after the true rash has faded. During the second week of the illness the symptoms become worse. Delirium becomes constant, though, if sharply spoken to, the patient may be recalled to himself for a moment. Sometimes the delirium is violent, sometimes of a low muttering kind. As the disease progresses the tongue becomes dry and brown, the pulse faster and weaker, and the general weakness so marked

ERUPTIVE FEVERS.

THE APPEARANCE OF THE RASH IN SMALL-POX AND CHICKEN-POX. Plate VII.

Confluent Small-pox in unvaccinated person. Early Stage.

Ear in confluent Small-pox. Mature Stage.



Chicken-pox. 3rd and 4th day.

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that the patient lies well down in the bed, on his back, with mouth and eyes half open, and motions and water are passed in the bed unconsciously. Often the hands wander aimlessly about, picking at the bed-clothes, a sign of great prostration. About the fourteenth day, in favourable cases, the turn of the fever is shown by the patient falling into a gentle sleep, from which, after some hours, he awakes quite sensible, with the fever almost gone, but in a state of extreme weakness. With careful nursing he goes on showing signs of improvement in returning appetite and gradually increasing strength, so that at the end of three or four weeks he is quite restored. If the case is going to end unfavourably the prostration increases, and instead of the turn at the thirteenth or fourteenth day, deep unconsciousness sets in, the fever runs up, and the patient sinks under it. Convulsions may occur, in such a case, before the unconsciousness comes on. The case may be milder than has been described, the delirium being limited to a "wandering," or it may be much worse, death taking place within the first week, instead of towards the end of the second, the usual time in fatal cases.

Ten out of every hundred is about the death-rate in typhus fever, and the deaths under twenty are fewer than those above it.

The chief complication in typhus is congestion of the lungs, largely brought on by the intense weakness produced by the disease.

Treatment.—The patient should be treated in a large well-aired room, fresh air being in this case the best disinfectant. He should be kept strictly to bed to reserve the strength. For maintaining the strength careful feeding is necessary. Sips of milk, beef-tea, nourishing soups from which all vegetables have been strained off, should be given *at short intervals.* The patient will in this way be induced to consume a large quantity in twenty-four hours, which he would not otherwise take. Thirst is to be relieved by barley-water, lemon-juice in water, or plain water. An occasional dose of castor-oil may be necessary to relieve the bowels, and at proper intervals the patient must be told to make water, since the intense listlessness of the patient may lead him to fail to do so. Sometimes the water requires to be drawn off. *The patient must never be left unwatched.* Delirium, which sometimes needs restraint, is to be met mainly by quiet, darkening the room, and applying cold cloths to the head. Stimulants, though not always necessary, are sometimes of great use towards the end of the second week, when the weakness is extreme, specially if the pulse is very fast and weak. They are doing good if the pulse becomes less frequent and stronger. The best stimulant is perhaps wine, to be given in tea-spoonful doses at intervals to the extent of two wine-glassfuls in twenty-four hours, or brandy or whisky in milk, half a wine-glassful to be mixed with a breakfast-cupful of milk, and given in doses of two or three tea-spoonfuls at a time, the whole cupful to be given in twenty-four hours. If cough, spit, and increased difficulty of breathing indicate congestion of the lungs, stimulants are to be used in this way. Twice the quantity noted may, in such a case, be given in twenty-four hours if it seems doing good. During the period of extreme weakness the attendant must guard against bed-sores by keeping the patient scrupulously clean, and by changing his position occasionally, so as to prevent the same parts being constantly pressed upon. During recovery strength is to be aided, not by stimulants, unless really necessary, but by careful nursing and feeding, frequent small quantities of nourishing beef-tea, soups, &c., being given.

Typhoid Fever (*Enteric Fever—Intestinal Fever—Bilious Fever—Gastric Fever*). Up till 1840 two fevers were confounded under the term *typhus* fever, but that two essentially different diseases were included under the one name was pointed out at the time mentioned by Dr. A. P. Stewart. Later a complete distinction was drawn between the two by Dr. William Jenner, the one described in the preceding paragraphs retained the name typhus, and to the other, because it was very like typhus in many particulars, the name *typhoid* was given. This fever (typhoid) is accompanied by serious disease of the bowel, and consequently to it the name enteric fever (from *enteron*, Greek for the bowel) has been given by some who do not like the confusion that two words, so like one another as typhus and typhoid, may occasion. The phrase "intestinal fever" is thus simply another phrase for "enteric" fever. Further, this fever is marked by sickness and by very decided diarrhœa or looseness of the bowels, and thus as the symptoms marked out the stomach and bowels as the chief seats of the disturbance, the name *gastric* fever has also been used for it. This term is not now being used by modern physicians, for it is essentially a bad one. Typhoid fever is an extremely serious and a very commonly fatal disease, but there may be many

disturbances of the stomach, accompanied by fever, but attended by no risk, to which the term "gastric fever" might be applied by some. It is a matter of the utmost moment that wherever typhoid fever exists it should be discovered; and the use of any term that would in any way tend to disarm suspicion as to the true nature of the disease is undesirable. It is quite certain that two diseases are very often confounded under the phrase gastric fever, namely, gastric catarrh (described on p. 158) and typhoid or enteric fever. Typhoid fever is often accompanied by severe vomiting, in which bilious matters are vomited, and hence some have called it *bilious fever*.

The cause of typhoid fever is almost certainly some living organism or germ, such as have been described on p. 393. No one, however, has as yet been able to separate the actual living thing which produces it. There is, nevertheless, sufficient evidence to lead to the conclusion that the poison of typhoid fever is not cast off from the body of the person sick of the fever, by the breath or by the skin, as occurs in measles, scarlet fever, and small-pox. This disease is, on this account, not infectious in the same way as the others mentioned are. It seems quite clear, on the other hand, that the typhoid fever poison is cast off from the bowels in the motions passed from them. It is also clear that the poison consists of living particles, and that, if they cannot live and multiply in the air, they can and do multiply in water. Thus the discharges from typhoid fever patients, cast into drains, find in the pipes and cesspools, particularly if they are not properly flushed with water and if they are blocked so that the refuse is stagnant, most favourable circumstances for their growth. It is also certain that drainage from a dung-heap, on which discharges from a case of typhoid fever have been thrown, getting into a well, can poison the water so that every one who drinks of it is liable to be attacked by the fever. It has been proved to be thus that typhoid fever suddenly appears and spreads among the population of a town, becomes, that is to say, epidemic. Happily the causes of such epidemics have been carefully traced. The history of them has been discovered again and again, and it is commonly something like the following. In a dairy farm one of the persons takes ill of fever, and is ill for several weeks at least. There is no particular medical attendance, and the character of the fever is not known by the farm people. The discharges from the sick person are thrown on to a dung heap or thrown out carelessly anywhere. Drainage from this gets into the well. The water from the well is used to wash the milk vessels, and probably to dilute the milk, and the milk is sent into the neighbouring town. The fever poison has multiplied in the well, has got into the milk with the water, has multiplied in the milk, and has been thus introduced into the stomachs of a certain number of the townspeople, among whom, in a short time, there is an outbreak of the fever. If, then, typhoid fever is not infectious in the same way as measles, scarlet fever, &c., it is at least infectious to this extent, that people eating food or drinking water, milk, &c., containing the poison are likely to take the disease. These facts are of immense practical importance, since they show that a person may attend on a case of typhoid fever without fear, if care be taken that all discharges from the patient, and all linen soiled with them, are carefully disinfected and disposed of.

Typhoid fever may occur at any age, though it becomes less frequent as age advances. No class or condition of men is free from its attack. It is most frequent in warm seasons of the year, and least frequent during cold weather.

It appears that some persons are able to resist the influence of typhoid fever poison much more successfully than others, so that not only must the poison be introduced into a person's body, but the person must be in a favourable condition for its growth within him. A lowered state of general health, from whatever cause arising, is undoubtedly one of the most favourable conditions for the attack of this disease as of many others. While one attack of the disease seems to afford some protection against a second, many second attacks have been recorded.

Symptoms.—It is uncertain what time elapses between the period of the introduction of the poison into the body and the commencement of the disease. It appears to be about three weeks. The disease usually begins by the person feeling unwell, and losing appetite. The loss of strength and general feebleness are marked. He complains of feeling chilly and then of feverish turns, of being drowsy, troubled with headaches, and of restless sleep at night. These are all vague general symptoms. But there are also disorders of the stomach and bowels, vomiting and looseness. These are often the most striking symptoms, and should make one suspicious. The temperature of the person should be taken. It will be found higher than usual (see p. 10). The pulse will be found fast, and the tongue

coated and brownish down the centre. One symptom should be tried for. It is pain on pressure in the right groin. If one presses this part with the fingers, generally gurgling will be felt, and the patient complains of some degree of pain. If the bodily heat be determined by the thermometer as described on p. 10 it will be found that the fever is highest at night and is lower in the morning. This daily rise and fall of the fever is peculiar to this disease. The rash comes out in the second week of the disease. It consists of rose-coloured spots about the size of a pin's head, raised above the skin, found principally on the chest, belly, and back. (They are represented on Plate VI.) They come out, only two or three at a time, in crops, and they fade in three or four days. But one crop after another continues, till the end of the third week. At this period (the second week) the tenderness of the belly and looseness of bowels are more marked. The motions may be very frequent and resembling pea-soup. The other symptoms continue, and the tongue is dry and tends to crack on the surface. Towards the end of the second week the fever continues, the tongue is more dry and brown, pulse faster and more feeble, the person grows dull and listless, is very prostrate, and there is delirium. The delirium may be violent, or simply rambling, or muttering. In the course of the third week the weakness becomes excessive and bed-sores are apt to form. The patient tends to slip down in bed. The body is wasted, the lips trembling, the pulse is extremely feeble and quick. Irregular starting of the limbs occurs, and the hands wander aimlessly about, picking at the bed-clothes. Blood is frequently passed in the stools. If the case is going to end in death, the starting of the limbs and wandering of the hands are marked, the motions and water are passed unconsciously in bed, and stupor comes on. A favourable turn is indicated by a gradual fall in the fever, a less frequent and more distinct pulse, a passing off of delirium, cleaning of tongue, and stoppage of looseness of the bowels. Recovery is always gradual and very slow. Many months may occur before strength is re-established. Relapses are not uncommon, attended by rash and all the other symptoms of the disease. They occur usually about ten days after the disappearance of the fever of the first attack.

While the symptoms that have been described are those of a typical case of typhoid fever, it must be observed that cases are very numerous where the symptoms are very obscure, and where, in consequence, the disease is apt to be overlooked. A patient, for example, may complain of chilliness and feverishness, of headache and unaccountable wearied-ness, of loss of appetite, and sleeplessness at night, and may exhibit no marked looseness of bowels, no spots on the skin, and no symptom pointing out typhoid fever with any certainty, while it is this disease which is attacking him. He may fight against his feelings of illness for seven or eight days, and then speedily succumb to the disease. Perhaps some great and sudden discharge of blood from the bowels occurs, or other grave sign of the mischief going on in the bowels. In all such cases the vagueness of the symptoms must not be allowed to make one indifferent. If the temperature is taken as advised (p. 10) it will probably give such warning as ought to lead to the person being sent to bed and being subjected to careful nursing and watching.

The **complications** of typhoid fever are numerous. The looseness of bowels indicates serious mischief there. It is found that the bowels are the seat of patches of ulceration occurring in the position of the glands of Peyer (p. 140). Now, in the process of ulceration a blood-vessel may be opened and fatal loss of blood may occur. The bursting of the vessel may be due also to improper exertion or to the taking of some hard food. In severe cases the blood is passed unaltered or in clots. Usually it is altered and makes the motions black and offensive. Where the loss is sudden and great it is known by the sudden paleness of the patient, and the failure of the pulse, and fainting. Bleeding may occur between the middle of the second and the end of the fourth weeks. Another danger is that the ulceration may eat through the bowel wall into the cavity of the belly, and there set up fatal inflammation (peritonitis, p. 190). It is shown by rapid swelling of the belly, violent pain, vomiting, great anxiety of the patient, and extreme frequency and feebleness of pulse. This occurrence is most common in the third, fourth, and fifth weeks of the disease.

Congestion and inflammation of the lungs are also exceedingly common.

Treatment.—As has been already said, many cases of typhoid fever present no marked symptoms. Nevertheless every suspicious case must be treated with watchfulness, and the mild cases with the same care as the severe. The patient should be put to bed and kept there. Often a person feels so comparatively well in the morn-

ing that he wishes to get up for a little. *This must on no account be permitted.* The patient should be daily sponged with lukewarm water, and the body and bed linen must be kept clean and dry and frequently renewed.

Perhaps the most important thing in the treatment of the case is the dieting. Only soft or liquid foods are allowed. Milk in abundance, beef-tea, light mutton broth, boiled bread and milk, lightly boiled egg switched, corn-flour, &c. &c. If the bowels are loose beef-tea tends to make them worse. This is to some extent corrected by the addition to it of rice, or thickening with corn-flour. *Overfeeding must be guarded against.* If the motions are mottled with white curd of milk, the quantity of milk supplied must be reduced at once, as these curdy lumps will seriously disturb the already inflamed bowel. *It is always best not to permit the patient to have much food at one time, but to give small quantities often.* Thirst afflicts the patient, and ordinary water in moderate quantities is not to be refused. Barley-water may also be given, and water made slightly acid with dilute sulphuric acid or ordinary vinegar.

As regards drugs, opening medicines must be cautiously given. At the very beginning a good dose of castor-oil may be administered. The ulceration going on in the bowel must be remembered, and if, later, the bowels require relief, it is best to give an injection of soapy water or weak tea of chamomile flowers. Looseness of the bowels, if excessive, is to be checked by the catechu and chalk mixture, with the addition of laudanum, if necessary, to a grown-up person. (See PRESCRIPTIONS—CHALK MIXTURE.) Bleeding from the bowels is restrained by a half to one tea-spoonful of liquid extract of ergot (spurred rye) if it is obtainable, to be given every two or three hours, as long as required. Failing that, 10 to 15 drops of turpentine every three or four hours, for several doses, may be given in a little olive-oil. Dilute sulphuric acid (10–15 drops) may also be given instead of these. If pain and swelling of the belly occur, the remedy is laudanum, 25 drops in water, repeated every two or three hours, to keep down pain. As to stimulants, they are never to be given as a matter of course. They are valuable only in the later stages of the disease when weakness is excessive, the pulse exceedingly feeble, &c. In such a case whisky or brandy is the best. It should be given in the following way: a wine-glassful of whisky is mixed with a breakfast-cupful of milk. Three or four tea-spoonfuls of the mixture are given at such intervals that the total quantity is not all used up for twenty-four hours. In extreme cases double this quantity may be necessary. But it should always be given in the way described, as thus one knows exactly how much is being given. The vessel containing the whisky and milk should of course be kept covered.

For weeks after the disappearance of the fever great care is necessary. Even in mild cases the person should on no account be allowed to sit up for a week after complete disappearance of fever, as shown by thermometer (p. 10). Even weeks after apparent recovery, improper exercise or improper food may lead to serious mischief in the bowel. All hard food should therefore be avoided for weeks after recovery.

These directions have been given for the benefit of any who may be in circumstances in which medical advice cannot be obtained. But the difficulties and dangers of typhoid fever even in its mildest form are so grave that only physical impossibility to obtain competent advice can justify any unskilled person attempting to take charge.

The fact that typhoid fever is contagious by means of the discharges from the patient must not be forgotten. Care must be taken to disinfect them in the manner described on p. 396. All linen also must be disinfected. In the country special pains must be taken that the discharges are not thrown where they may find their way into wells or burns from which a water supply is taken. It is in this way that contagion is spread, if the polluted water is used for domestic purposes.

Dandy-fever (*Dengue, Three-day Fever, Break-bone Fever*).—This is an infectious fever, not known in Great Britain, but occurring in India, Burmah, Egypt, Persia, North and South America, and the West Indies. It was first recognized in Rangoon in 1824, when it broke out among a body of troops. It attacks persons of both sexes and of all ages.

Symptoms.—The fever presents symptoms resembling rheumatic fever, scarlet fever, and ague. It often begins suddenly with severe pain in some joint, specially a finger joint. The pain jumps from one joint to another, soon attacking many. There are high fever with shiverings, loss of appetite, great weariness, sickness, and pain in the head and eyeballs. The rash comes out on the third day and is like that of scarlet fever, the face being red and puffy, the throat red and

sore, the eyes red, and a general redness being over the body. It is usually accompanied by itching. The pulse is frequent, breathing is quick, and the tongue is covered with a white coating out of which red points project. On the fifth or sixth day the rash passes off, and the fever falls, and comparative health is restored. This lasts, however, only for from two to four days, when the fever returns, and a second rash resembling measles or nettle-rash (p. 314) appears. The second attack lasts two or three days and gradually passes off, much of the scarf-skin often separating. Though the fever passes off, the pain and swelling of the joints, especially in the smaller ones, remain, and may continue to afflict the patient for weeks. Further, more than a second relapse may occur, making recovery slow and doubtful. In ordinary cases, however, eight days is the average length of the disease. In the course of the fever delirium, in children convulsions, may occur.

Treatment.—Gentle movement of the bowels should be regularly obtained, but there should be no purging. The ammonia and ether mixture (see PRESCRIPTIONS) should be given in tea-spoonful doses every two or three hours. The addition of tincture of belladonna is recommended, and two or three doses of from 5 to 10 drops may be given at intervals of an hour, the mixture being afterwards given alone. If the fever runs very high cold sponging is useful. The joints may be rubbed with opodeldoc (soap and opium liniment) or with a liniment of opium, chloroform, and belladonna. During recovery quinine tonics are of great help. The following may be used:

Quinine, ...	...	16 grains.
Dilute sulphuric acid, ...	...	2½ drachms.
Infusion of calumba,	to make	8 ounces.

Of this a tea-spoonful should be taken in a wine-glassful of water three or four times daily.

Food should be mild and nourishing, milk, light soups, rice, &c., and often change of air is very valuable in getting rid of the lingering affection of the joints.

INFECTIOUS FEVERS WITHOUT RASH (ERUPTION).

Influenza (*Epidemic Catarrh*).—This is an affection similar in its general characters to the disease described as catarrh (p. 154) or common cold-in-the-head. Indeed to cold-in-the-head, when accompanied by sharp fever, pains in the bones, and sickness, the name influenza is often applied. The true influenza is, however, remarkably infectious, which common catarrh never is. In fact influenza is one of the most remarkable of epidemic diseases, capable, as it is, of running through a whole community with marvellous rapidity. Thus one epidemic of it, in 1782, spread over all Europe, missing no country of it, affecting more than half of the people and killing many. Many epidemics of it have occurred since then. The infection is apparently conveyed by the air.

Its **symptoms** resemble those of ordinary catarrh. Its attack is very sudden, and is indicated by chills along the spine, and flushes of heat, high fever, pains in back and limbs, and perhaps sickness. The lining membrane of nostrils, eyelids, mouth, and throat becomes dry, red, and swollen. There are sneezing, intense pain in the forehead and eyeballs, inflammation of the throat and tonsils (p. 136), soreness of throat, harsh croupy cough, and a sense of tightness and pain in the chest. The skin is dry, the tongue white, the bowels confined, and the appetite is lost. The excessive weakness that is rapidly produced is a very marked symptom. In a short time the dryness of the nostrils yields, and a free discharge of watery material comes from them; there is also spit. About the same time the skin becomes more moist, and sweatings occur. Later the discharge from the nose and throat is mattery, and difficulty of breathing and cough are marked. A number of blebs occur on the lips very often. In about three or five days the attack passes off, usually with free sweating, leaving the patient extremely weak and afflicted with troublesome cough. The disease may, however, last several days longer, owing to inflammation attacking the tubes of the lungs and passing downwards, marked by increased difficulty of breathing, hoarseness, cough, and darkening of the face and lips, owing to the affection of the lungs. Bronchitis (p. 270) inflammation of the lungs, that is, pneumonia (p. 274), and other diseases may thus complicate the attack, and delay recovery or cause death. Though death is rare, it is from such complications that it arises.

Treatment.—The patient must be kept in bed in a room kept at a moderate and regular warmth. The kind of food allowed is milk, corn-flour, beef-tea, &c. In case of thirst, barley-water, meal-water, lemonade, soda-water may be given in ordinary quantities. At the very commencement the feet and legs of the patient should be placed in a hot bath containing sufficient mustard to produce a feeling of

tingling, and a hot drink should be administered. The following mixture is useful:

Solution of acetate of ammonia,	2 ounces.
Spirit of nitrous ether, ...	⅔ of an ounce.
Ipecacuanha wine, ...	¼ of an ounce.
Water, ...	to 4 ounces.

Give a large tea-spoonful in water every two hours to grown-up persons, and less to children in proportion to age. For grown-up persons 4 drops of laudanum may be added to each dose, *but not for children.*

If the cough is very troublesome let a kettle be kept boiling on the fire and pouring its steam into the room; and if the throat and chest are sore apply hot poultices of bran or linseed-meal over the throat and upper part of the chest. The bowels should be relieved by seidlitz powders, or citrate of magnesia, or by injection. If the chest is seriously affected, hot poultices all over give great relief, and a cough mixture of ipecacuanha wine and squills (see PRESCRIPTIONS—COUGH MIXTURES) may be given. During recovery, nourishing foods, iron and quinine tonics, &c., are required. Stimulants are often required in the period of extreme weakness. Their use should be regulated by a medical man. If advice cannot be obtained, let 4 teaspoonfuls of whisky or brandy be put into a cup of milk, and let it be given in sips so as to be used up in 12 hours, when a fresh quantity should be made for the next 12 hours.

Hay-fever is described on p. 274.

Whooping-Cough.—This is specially a disease of children, though grown-up people may also be affected with it. Girls suffer more than boys. It is extremely common in children, standing next to scarlet fever as a cause of death. The greatest number of cases occurs in children under eight years of age, and it is more fatal in spring and autumn than at other seasons of the year. It is the most fatal of all diseases to children under one year of age, and three-fourths of all the deaths from it are of children under two years, while only six per cent of the deaths occur above five years. It is, therefore, a disease from which children under five years of age should be most carefully guarded. *It is an infectious disease,* the cause of the disease being given off in the breath of the person suffering from it, and being capable of conveyance by the air and by clothes also. It is specially infectious in the early period of the attack. One attack almost perfectly protects against another. Now taking these two facts together, the terribly fatal character of the disease among young children, and its extremely infectious nature, how great should be the care taken by mothers and nurses to prevent its spread and to protect their children from it. Yet it is the commonest thing possible to find mothers carrying children affected by it in public conveyances, tram-cars, and the like; and very insufficient pains are taken, when it appears in a household, to separate the affected child from the others.

Symptoms.—The earliest symptoms are like those of a common cold, with considerable fever. They begin probably a fortnight after infection has been received. The child is restless and feverish, pale and without appetite. Its breathing is quickened. It sneezes and has an irritable cough. The cough is very troublesome day and night, but specially at night. Fits of coughing come on; a quick short series of coughs ends in a long-drawn whistling breath, followed by another long cough. Some defluxion may be expelled at the end of the fit of coughing, and vomiting often occurs. After a week or a fortnight the fever lessens and the cough begins to be marked by the peculiar whoop, that gives the name to the disease. The cough still comes on in fits or paroxysms, in ordinary cases every hour, in severe cases every half-hour, and in bad cases even oftener. The child knows when it is going to come on by a tickling sensation. It becomes quiet and frightened, rushes to its mother or nurse, rises if it is lying down. The fit begins with a deep in-drawn breath, which is followed by a rapid series of short coughs, becoming weaker, till all air seems driven out of the chest; the face becomes swollen and bluish; the veins are seen full of blood; the eyes are starting, the skin wet with sweat; and the onlooker would believe that the child was choking, when the spasm, preventing the entrance of air into the lungs, begins slowly to yield, and as the air enters the narrowed opening in the windpipe, it produces a long, whistling, or crowing sound, the "whoop," of the disease. Two or three such attacks may occur quickly after one another, till the child is quite exhausted and faint. Often some defluxion is expelled towards the end of the attack, and vomiting is produced. The great strain on the blood-vessels may cause bleeding from the nose or other parts of the air-passages, and the eyes may become blood-shot. The child soon recovers and seems all right till another fit of coughing occurs. This stage lasts from four to six weeks or even longer, though sometimes it

may be only two weeks, and then the spasms become fewer and less severe and defluxion is more free. Health and strength gradually return, but complete recovery may often take many months.

The dangers of whooping-cough are the occurrence of bronchitis, of inflammation of the lungs, and of convulsions. The younger the child the greater is the risk of bronchitis rapidly overspreading both lungs. Without such complications recovery ought to take place, though death may occur during the spasm.

Treatment.—The child should be kept in a room constantly maintained at a moderate degree of heat. The air should be kept moist by steam from a kettle on the fire. The child should be clothed in flannel, and should get light nourishing food in small quantities often. The bowels should be kept regular by castor-oil or syrup of senna. The medicine to be given is bromide of ammonium and belladonna. Children stand large doses of belladonna, and the quantity may, therefore, be steadily increased in the following way: Let a mixture be made containing 64 grains of bromide of ammonium in one ounce of simple syrup (solution of sugar) and three ounces of water. Give a tea-spoonful of this every two or three hours. This is to be continued throughout the first week, and to it occasionally may be added four or five drops of ipecacuanha wine. When the second stage comes on, the same solution of bromide of potassium is to be used, and to each tea-spoonful, as it is about to be given, add one or two drops of tincture of belladonna. If the child stands this quantity well, after one or two days' experience, three drops of the tincture may be added to each dose, and after a further experience of a day or two with the three-drop dose, four drops may be added to each dose, and even five drops. As soon as the black of the eye appears very large no further increase in the quantity of belladonna is to be made. The object of the belladonna is to relieve the spasms of coughing, and as soon as they begin to yield, the quantity of belladonna is to be gradually diminished. To help recovery of strength when the disease is evidently over, nothing is so useful as change of air. This should not be sooner than six weeks after the commencement of the illness. As a tonic to aid recovery, a half to a tea-spoonful dose, according to age, of syrup iodide of iron may be given thrice daily. The infectious nature of the disease must not be forgotten, and disinfection should be practised as described on pp. 395 and 396.

Diphtheria and Croup.—These two diseases will be considered together, since according to many authorities, they are the same disease, which is called diphtheria when it principally attacks the tonsils and parts in their neighbourhood, and is called croup when it principally attacks the top of the windpipe—the larynx (p. 250).

Diphtheria is a contagious disease, the result of the introduction into the body of the person who suffers it of a particular poison. The poison may be harboured on clothes and so carried about. It is thus capable of spreading, of giving rise to an epidemic. In some places it is more or less constantly present, is, that is to say, endemic, probably because of some bad sanitary condition. It occurs in every climate and season. It may attack persons of any age, but is most common between the ages of two and ten years. It seems to have some relationship to scarlet fever, for in many cases diphtheria occurs after scarlet fever.

Symptoms.—The disease begins to show itself within a few days after the poison has been received into the body. But the symptoms may be so ill-defined and vague that the disease is far advanced before the patient really appears seriously ill. The symptoms at the commencement are chills and feverishness, loss of appetite, general weakness and dulness, and marked paleness of skin. Sometimes in the child the first thing that attracts attention is a complaint of soreness of throat. When the throat is examined, already there may be seen the presence of white patches that too surely indicate the nature of the disease. These are patches of false membrane, of a dull white or grey colour, like pieces of wash leather. They are placed on the tonsils and neighbouring parts of the back of the throat. The patches are small to begin with, but they tend to spread and join one another, so that in severe cases the whole back of the throat, including tonsils and uvula (p. 136) is covered with the membrane. If the membrane be scraped it separates in shreds, but grows on again. The throat is also considerably swollen; indeed, even though only one side is attacked, the swelling may be so great as almost quite to block the passage. The glands at the side of the jaw are also swollen. As a result of the swelling there is difficulty of swallowing, though the attempt to swallow does not produce the intense pain common in a severe attack of quinsy (p. 155). In many cases swallowing can be performed all through the illness. The swelling and loss of appetite com-

bined render the patient not inclined to take food, and in children this is a cause of much trouble. For a marked feature of the disease is the excessive prostration it produces. It is to combat this that remedies are, from the first, directed; and so where disinclination to swallow exists, there is great difficulty in getting sufficient food taken to maintain the strength. The disease may not go beyond the stage described, and in ten days or a fortnight recovery begins, the membrane separating in pieces, and being spat out or in young children swallowed. The breath is frequently very foul, because of the decomposition of the false membrane. Even after the throat is quite clear and clean, the patient remains extremely feeble, and in some cases the voice is altered, perhaps lost for a time, owing to paralysis.

But the membrane may extend up into the back of the nostrils and down the gullet towards the stomach, and the disease may be so prolonged that the patient dies of exhaustion.

A most frequent and the most fatal form of the disease is that in which the formation of the false membrane proceeds downwards into the windpipe. The symptoms of this occurrence are those of **croup.** The voice is hoarse, and there is a short dry cough of a peculiar character. It is hoarse and muffled, "like the distant barking of a puppy." Sometimes it is a brassy sound. Accompanying the progress of the disease down the windpipe there is increasing difficulty of breathing. These signs are of the most serious nature, especially so in children, in whom the passage of the windpipe is narrow and easily blocked. As the membrane thickens the voice is lost, and the cough becomes muffled and almost noiseless. Suffocative fits come on, partly due to spasm, partly to the membrane blocking the air-passage, and the patient struggles for breath, the face becoming blue and the eyes staring. One fit passes off, and the patient becomes easier, but speedily another comes on, the person at last sinks into a state of exhaustion and stupor, and death occurs. Usually the end happens before the fourth or fifth day after the symptoms began. Now, sometimes the disease attacks the air-passage only, without any previous attack of the tonsils, no white patches being seen at the back of the throat. In very young children the formation of the membrane in the windpipe may proceed so quickly that death occurs within a few hours of the hoarseness and cough indicating the disease.

The membrane may also pass up into the nostrils from behind, and be evidenced by stopping of the nostrils and discharge of matter and blood.

Further, there are cases of diphtheria in which death occurs within a few days, even in grown-up persons, not from suffocation, but from the violence of the poison and the exhaustion produced. Indeed, death may occur without any apparent formation of membrane, and so rapidly as to leave some doubt regarding the true nature of the disease.

Nor yet is all danger passed when the throat affection has passed away, for death may even then suddenly occur from loss of blood, failure of the heart, and other causes.

Treatment.—The person is to be put to bed in a large well-ventilated room, which must be kept continually at a moderate heat, and in which no draughts must be permitted. A fire must be kept on constantly, and a kettle should always be on the fire pouring its steam into the room. If the least suspicion of the throat being affected is present, the kettle should be a bronchitis kettle (see Plate VIII.—NURSERY APPLIANCES), and the steam should be plentifully poured in the immediate neighbourhood of the bed. If the bowels are confined castor-oil must be given, or an injection. From the beginning every effort should be directed to maintain the strength, sips of warm milk or warm beef-tea, strong mutton-broth, freed from fat and vegetables, eggs beat up in milk, &c., should be administered in small quantities often. Port wine in small quantities is also to be frequently administered. Cold drinks are not to be withheld, and ice may be given to suck. When the patient cannot swallow nourishing injections become necessary. The method of administering them is explained in another part of this work. (Refer to index for INJECTIONS.)

The treatment by medicine is twofold. The throat must be regularly painted several times daily, in the hope of arresting the growth of the false membrane, and a mixture is to be given. The paint is made of equal parts of glycerine and liquor of perchloride of iron—the strong liquor. To each ounce of this one drachm of sulphurous acid is added, and the whole shaken together. A brush is used—camel's hair or goose quill—firmly set on a long handle. The tongue of the patient is held down by a spoon, and the back of the throat thoroughly painted over. The painting must be repeated twice or thrice daily. With children it is difficult to accomplish, and help is necessary. A new method consists in drying the throat as well as

possible and then painting it with Tolu varnish. The following mixture is to be given:—

Chlorate of potash in powder,....	120 grains.
Solution of dialysed iron, ...	½ ounce.
Syrup of orange, ...	1 ounce.
Water, ...	to 4 ounces.

Of this from a half to one tea-spoonful is to be given four or five times daily. When suffocation is threatened steam is to be kept streaming about the bed, and hot cloths may be applied on the neck. A surgeon would probably suggest opening the windpipe by the operation known as tracheotomy (p. 270). During recovery quinine and iron tonics, nourishing foods, cod-liver oil, and, when the patient can bear it, removal to the sea-side, are valuable aids to full restoration of health.

Disinfection (p. 395) must not be forgotten.

Croup, true croup, has been considered in the preceding paragraphs as an extension of diphtheria down into the top of the windpipe—the larynx (p. 250), or into the windpipe itself; or it may be the diphtheria attacks the larynx and windpipe first and directly. There is, however, an ordinary inflammation of the top of the windpipe and windpipe itself not attended by formation of false membrane, to which children, of two and three years old, are specially liable, to which the term croup is also applied.

Its **symptoms** may come on suddenly with alteration of voice, some hoarseness, and frequent dry short cough. The cough speedily takes on special characters, it becomes barking and "brassy." There is fever with difficult and hurried breathing, crowing and piping noise with taking in of breath, quick pulse, and the child is restless and anxious and plucks at its throat. Now it may be impossible to say whether the symptoms are due to the formation of a false membrane in the windpipe, as in diphtheria, or to inflammatory swelling. Death may occur by suffocation or exhaustion, and very speedily.

Croupy symptoms are often present at the commencement of measles.

The **treatment**, in so far as it differs from actual diphtheria, is the same as that described on p. 270 for inflammation of the larynx, and consists principally in the use of hot poultices and cloths over the front of the neck, and the use of steam, hot drinks, &c.

Relapsing Fever (*Famine Fever—Bilious Remittent Fever—Seven-day Fever—Irish Fever*).—This is a fever that seems to be related to periods when extreme poverty prevails, hence its term famine fever. So far as Great Britain is concerned, it came from Ireland, and hence was called Irish fever; but it has also appeared in America, India, Africa, and Russia.

It is undoubtedly due to the presence of a living germ in the blood, is contagious, and may be carried long distances by infected persons and by clothes.

Symptoms.—It is doubtful what period passes after the poison has been introduced into the body before the attack begins, sometimes apparently only a few days, at other times about a fortnight. The attack begins with shivering fits, pain in the forehead, back, and limbs, high fever and great dryness of skin. Appetite is lost; there is thirst; the pulse is very fast; the tongue is covered with a thick white coating, the tip and edges being red. The bowels are confined; there is pain over the stomach, and to the right side over the liver; and vomiting occurs. Jaundice, yellowness of the skin, occasionally appears about the second or third day, hence the idea that the fever is a bilious one. The pains in the joints are of a rheumatic character. Towards the end of the first week there may be delirium. In from five to seven days from the beginning of the attack the fever suddenly passes away, usually after copious sweating, lasting for a few hours, or after free discharge from the bowels. The other symptoms also disappear, but the patient is left weak. For about a week he remains apparently well, and then a second attack suddenly comes on, similar to the first, lasting about three days, and ending like the first. A third attack may follow. Purplish spots may appear during the disease, though there is no regular rash.

Deaths from relapsing fever are not common. Weakness produced by the fever is great, and recovery is slow. The complications apt to occur are affections of the lungs and bowels, looseness, and dysentery.

Treatment.—Light food of milk, corn-flour, beef-tea thickened with rice or corn-flour, is to be given in small quantities. Cold sponging, when the heat is great, with water containing a little vinegar, is refreshing. The patient may have ice to suck, and tea-spoonful doses of the following mixture are to be given every three hours:—

Solution of acetate of ammonia, ...	2 ounces.
Spirit of nitrous ether, ...	¾ of an ounce.
Water,...	to 4 ounces.

To relieve pains and help sleep 5 drops of laudanum may be added to each dose, *but only to*

grown-up persons. The bowels should be moved by castor-oil or by injections. No medicine prevents the relapse. Recovery is to be aided by light nourishing foods, and quinine tonics.

The contagious nature of the disease must be remembered, and the rules for disinfection (p. 396) followed.

Plague (*Pestilence—The Pest—Black Death*).—This is a disease believed to have been observed as early as the second century before Christ. It was common in Egypt, other parts of Africa, and Asia. In the sixth century after Christ it spread over Europe. From that time it continued to exist in Europe, breaking out at intervals in fierce epidemics. Towards the end of the seventeenth century it began to disappear from Europe, from which, however, it had not quite departed till 1841. The last attack in Great Britain was the Great Plague in London of 1665. It seems still to exist in Arabia, Persia, and other parts of Asia. Starvation, filth, and overcrowding are the conditions that favour its spread. It is extremely contagious, being communicated by the breath and carried about by clothing. In many respects it resembles typhus fever.

Symptoms.—The disease appears about five days, on an average, after the poison has been taken into the body. The following are the chief points of the description given of it. It begins with shivering fits or chills, with fever, pain in the forehead, back, and limbs, and great weakness of body. The patient wears a dull, stupefied haggard look. From the second to the fourth day of the disease swellings of glands (buboes) appear at the angles of the jaws, in the armpit and groins. The eyes are red, skin hot, tongue as if covered with wool, or dry, black, and cracked. The gland swellings cause pain, and come to matter if the patient does not die before. In some cases boils or carbuncles appear on the limbs generally, and purple spots (*petechiæ*) are not uncommon. Sickness and vomiting of bilious matter and perhaps bloody matter are frequent.

Death within twenty-four hours of the beginning of the attack is frequent, and the majority of deaths occur within four or five days. The death-rate is not less than one in three.

Treatment is similar to that of typhus fever. No treatment that can cut short the disease is known. Disinfection and avoidance of the conditions of the spreading of the disease, uncleanliness, overcrowding, &c., are the means to prevent its extension.

Yellow Fever (*Black Vomit—Yellow Jack*) is a disease of hot climates, common in the West Indian Islands. It has been introduced into Europe, but does not tend to spread except in times of great heat. Cold kills it. It attacks Havana almost yearly between the months of April and December. It is rarely absent from the West Indies, and is most fatal from May to August. It is a contagious disease, and its contagion can be carried by clothing, and conveyed by infected ships. A person who has suffered from one attack is safe from a second.

The **symptoms** may appear within one or two days after the poison has entered the person's body, or may not occur for six or ten. The attack is sudden, beginning with shivering, fever, dry skin, intense headache, pain in the back and limbs. The eyes are glistening, bloodshot and red; the face is congested; there are great thirst, loss of appetite, tenderness over the stomach, sickness and vomiting. The tip and edges of the tongue are very bright red, the rest being covered with a white coat. The lips and throat are also bright red. The pulse is at first very fast, but may greatly diminish in speed, even while the fever remains high. The fever may not remain high for more than a day or two, but the vomiting and tenderness over the stomach continue. At first the vomit is of the contents of the stomach, then it becomes coloured with bile, and later has a "coffee-grounds" appearance, the black vomit, due to mixture of altered blood. The motions are often black for the same reason. By the second or third day of the disease the whites of the eyes may be seen to be yellowish, and the yellowness spreads to the face and over the body, the jaundice being well marked. The urine, which is at first clear and of the usual quantity, becomes, with the advance of the disease, of a deep yellow from the presence in it of bile. The colour may deepen to orange red, and at the height of the attack almost no urine may be made. In favourable cases the quantity becomes large and the colour becomes very dark. Death may take place within a few hours of the attack from the violence of the poison, the person becoming collapsed. It may occur at any time in the progress of the disease, the fifth day being regarded as critical. In cases that have gone on for several days death is usually due to bleeding from the stomach or bowels or kidneys, or from exhaustion of the heart. Where recovery takes place it is gradual, and the jaundice takes long to disappear. The death-rate is very high.

Treatment.—The patient should be confined

to bed and all exertion strictly forbidden. The room should be large and well-aired, but kept constantly at a moderate warmth. The bowels should be relieved by injections. Corn-flour, beef-tea, chicken broth, milk, and similar food should be given at regular and short intervals. Large draughts of lemonade and barley-water are to be allowed. Ice is to be sucked to allay sickness, and for the same purpose mustard poultices are applied over the stomach. In cases of recovery the person must not be allowed to sit up till fourteen days have passed.

It is needless here to mention any of the many drugs tried for the disease. All discharges from the patient must be at once disinfected, as recommended on p. 396, and removed, and other steps taken to limit the disease (see p. 396).

Hydrophobia (*Dog-Madness—Rabies*).—The word hydrophobia is derived from two Greek words, *hudōr*, water, and *phobos*, fear, the dread of swallowing and the spasms produced by the attempt being a marked feature of the disease. It is a disease to which dogs, cats, wolves, and foxes are liable. It is due to a particular poison, which seems specially to exist in the saliva or spit of the animal affected by the disease. It can only be produced in human beings by the direct introduction of this material into the body by a bite or other wound. A person may be bitten by a dog and may in consequence be seized with the disease, although the dog did not at the time show signs of the disease. Cases have been due to a dog, not known to be suffering from the disease, licking the hand of its master on which some slight wound was present. The bite of a cat may produce it. Probably, however, not more than a third of the persons bitten by mad dogs take hydrophobia, even when no attempt has been made to destroy any poison that may have been imparted from the dog's mouth. When the bite has been through clothes the risk is less than if the part of the body had been uncovered. More men suffer from the disease than women. There seems no doubt that a bite from a healthy dog cannot produce the disease. A dog must be suffering from the poison, whether it is evident or not, before it can impart the disease to another.

Symptoms.—It is very doubtful how long the poison requires to reside in the body before the disease appears. The shortest interval between the bite and symptoms has been about twelve days. The interval is seldom less than a month, and is on an average six or seven weeks. In some cases many months have passed before the disease appeared, and some have been recorded in which the interval extended to years. The appearance of the disease after four months is, however, seldom. The wound by which the poison gained admission to the body usually heals as easily as an ordinary wound. It is said that among the first symptoms in many cases is return of pain to the place of bite, hot tingling pain, shooting from the part. Such is often not present. Other symptoms are restlessness, shivering, uneasiness, a feeling of illness, disturbed sleep, lowness of spirits, and discomfort about the throat with some difficulty in swallowing liquids in particular, while at the same time there is thirst. As the disease advances the patient becomes excited, the eyes look wild, and he wears an expression of terror, and is liable to outbreaks of delirious excitement in which he may strive to injure himself or others. The chief symptom is the spasm that occurs on attempting to drink. At first it is mere difficulty of swallowing, but soon the attempt causes a spasm, a "catch in the breath," which, in the course of a few hours, becomes marked as a strong contraction of the muscles of breathing, there being a strong effort as in taking in a deep breath, so that the shoulders are raised and the corners of the mouth drawn outwards. The spit cannot be swallowed. It collects in considerable amount, and hangs thickly from the mouth, a source of great annoyance to the patient. Even when the patient is quite conscious, the impossibility of swallowing is marked. The person may take a glass of water, and, making up his mind with great effort, may carry it quickly to his mouth with agitation, but the spasm comes on and the glass is violently thrown away, and any water that may have got into the mouth is violently thrown out, while the patient shudders, and marked spasms of the muscles for breathing occur. The very thought of drinking is terrifying. The mere sound of running water produces spasm, and the state of terror and agitation is extreme. In advanced cases any sudden noise, or a rush of cold air, will bring on a convulsive attack. As the disease advances the patient becomes feeble, the voice hoarse, and the convulsions more frequent and severe. Death occurs from exhaustion or from suffocation in convulsion. The disease is without exception fatal, death occurring in from two to six days.

In dogs the symptoms of rabies are sullenness, fidgetiness, and continual shifting of position. The dog seems to see things in the air, which he

gazes at, follows, and snaps at. His appetite is perverted. He swallows bits of coal, wood, &c. Saliva streams from his mouth, and hangs in sticky strings from it, disturbing him and causing constant efforts with paws to get rid of it. He makes a hawking noise in the effort to clear the throat and mouth. His bark is hoarse, and eyes bright. There is evidently intense thirst, and *the dog has no fear of water, for he often buries his muzzle in water at the height of the attack;* but he cannot drink owing to paralysis of muscles, or spasmodic irregular movements of them. He bites anything that comes in his way, and may thus in a short time infect other dogs, cats, and other animals. Finally the dog reels and staggers, his hind legs and lower jaw lose their power, and he dies in convulsions or from exhaustion.

It is to be noticed that nervous people, who have been bitten, may by mere mental anxiety work up symptoms resembling those of hydrophobia. This false hydrophobia may be known from the presence of anxiety alone and not delirium, from the spasm on drinking being a mere difficulty of swallowing, which can be overcome, and being overcome, does not return. In such cases if the patient's mind be set at rest, and some soothing medicine given, a 30-grain dose of bromide of potassium, for example, the symptoms disappear.

Treatment.—Whenever a person is bitten by a suspicious animal the circulation of blood ought at once to be stopped, for a brief period, in the bitten part by tying a tight band, if it be a limb, above the bitten part, and carefully washing the bite and allowing it to bleed freely. As soon as possible—immediately, if possible—the part should be burned. A hot iron, poker, &c., may be freely and deeply used, or nitric acid painted lightly over the place with a brush, and then wiped off with a sponge and cold water. Attempts to treat the disease have failed. Attempts may be made with chloral hydrate, in from 10 to 30 grain doses, to keep down the spasms. The patient should be kept very quiet in a dark still room. Persons in attendance ought to be careful, since a bite from a patient, or the spit of the patient cast on the attendant, may impart the disease.

Glanders and Farcy are diseases of the horse and of animals of the same species. They may be communicated to man by poison contained in the discharge from the nostrils of the diseased animals. It is, however, rare in man.

Symptoms appear from three to eight days after the introduction of the poison, and in some cases after a longer interval. They are high fever, great heat of skin, shiverings, quick pulse, pains in muscles and joints of a rheumatic character, headache, sleeplessness, profuse sour sweatings and clamminess of skin. The nostrils become congested, and a biting watery fluid comes from them, which soon becomes thick, and mattery. A rash, at first of red spots, like flea-bites, appears scattered over the face, limbs, neck, and belly. They become pimples like peas, grow yellow, and soon burst, pouring out matter, and leaving bad ulcers. The eyes yield matter; sores form in the mouth and throat, and the lungs become affected. Lumps, turning into boils, form in the skin on the face and in the neighbourhood of joints. The patient becomes very weak; delirium comes on, followed by stupor and death. The disease runs its course in sixteen days, on an average, but some cases end fatally in a week. It is usually fatal.

In glanders the nose and ear-passages are early affected. In farcy the poison is introduced in a wound on the body or limbs. The part becomes red and inflamed, glands in the neighbourhood become affected, and lumps (farcy-buds) and boils form in the skin. Both are, however, practically the same disease.

Treatment.—No curative treatment is known. The patient's strength must be maintained, as well as possible, by nourishing food and stimulants, and the affected parts should be carefully and regularly cleansed, abscesses opened and cleaned out, &c. A person attending a case ought to wear india-rubber gloves while bathing the affected parts.

Syphilis (vulgarly called *Pox*) is a contagious disease, is, indeed, a type of that class of diseases capable of being contracted only by the direct introduction of a special poison into the body of a person. The poison is, in this case, communicated directly by sexual intercourse or indirectly by inheritance. To this rule there are, however, exceptions which must be noticed, and will be stated in the course of the description of the disease. How the disease first originated, where, that is to say, the first poison came from, it is as impossible to state as to declare where the first poison of small-pox came from, or, for that matter, the first seed of corn or wheat or potatoes. When and in what place the disease first manifested itself it is equally impossible to decide. It appears, however, to have occurred in Europe, and certain parts of Asia, from the earliest times. It has spread

over the entire globe, by means of the commerce between countries, though there are yet some regions free from it. The disease is not affected by climate. During the latter part of the fifteenth century the disease assumed an epidemic form, and spread throughout the whole of Europe.

One attack of syphilis protects against a second, but then the disease does not run its course in the brief period occupied by other fevers, such as small-pox, scarlet fever, &c. Its progress occupies months, even years, and sometimes continues throughout the life of the person who has contracted it.

Symptoms.—The fearful character of this disease will be best understood by an account of the progress of an ordinary case, to arrest which no steps have been taken.

The first occurrence of the disease is the appearance of a sore, called the **hard chancre,** at the place where the poison has been introduced, usually some part of the genital organs. This sore, however, does not appear for a considerable time after the poison has been received. There is a period, that is to say, corresponding to the period of incubation or hatching of ordinary fevers, which has been referred to on p. 397. This interval is on an average four weeks. It may be only a little over two weeks, while, on the other hand, it may extend to nearly six weeks. During this interval there is nothing whatever to lead the person, who has exposed himself to the disease, to suspect the possibility of its existence. A person, whose conduct has rendered his infection only too probable, after failing to discover anything for a week or two, may conclude that he has (undeservedly) escaped, but this conclusion is not justified so early as this. The form which the sore takes on its first appearance is that of a small red dark-coloured pimple, which slowly grows larger. The person may be, and often is, unaware of its presence, since it is not painful nor itching. In a few days the pimple is broken by the separation of a part of the surface, and speedily a little ulcer is formed. The ulcer is of a peculiar character. It is not deep but shallow, and all round the sore is a firm ridge of a dark red appearance. If the part be taken between finger and thumb it has a hard feeling, as if a little mass of gristle had been deeply imbedded in the substance of the skin. The ulcerated surface is greyish, and rather dry, only a scanty thin discharge being produced by it. In about six weeks it reaches its complete formation, when it is about the size of a split pea, and it thereafter begins to diminish. When it is healed it leaves a white scar that will never disappear. The scar is below the level of the surrounding parts, which are somewhat hardened, and of a darker colour than is usual. So little trouble does this sore occasion, that the person may from first to last be ignorant of its existence. The sore is single; several of them do not occur on the same person. While this is the usual form and course of the sore, it may appear as a mere scratch or crack, healing easily and leaving scarcely any recognizable scar. What has been described is the true, hard chancre, the first result of the activity of the special poison of syphilis. But there is another sore, called soft chancre, or **chancroid,** also the result of the introduction of a poison, obtained in the same way as the preceding, but which never gives rise to syphilis. It is described elsewhere (see INDEX). It is painful, pours out abundant discharge, is accompanied by inflammation and swelling, but has not the hard gristle-like feeling of the true chancre. Moreover, matter from the soft sore, getting into a scratch on any other part *of the same person's body,* will reproduce a similar sore; while, on the other hand, matter from the true chancre cannot produce a second sore on the same person, though it can produce a sore like that it came from on another person. One or two weeks after the appearance of the *true* chancre, the glands in the groin become affected. In fig. 113 on page 208 is a representation of the glands in the groin. Those marked *d. e. f.* in the figure receive material from the genital organs, and if the poison of syphilis has been there introduced, it in time reaches the glands and affects them. They increase in size, not necessarily all of them, but several. The increase is slow and painless. On pressing with the finger, they are felt to be hard and are freely movable in their positions. They may become as large as almond shells, and so they remain for years, not coming to matter and giving rise to no trouble, but presenting almost conclusive evidence of the existence of syphilis. This is another distinguishing feature between hard and soft chancre, for the poison from a soft sore reaches the same glands, but causes in them inflammation and formation of matter, so that one or more buboes, as they are called, are produced, that is, abscesses, which are extremely stubborn and slow to heal.

And now there follow evidences that the poison has not only passed up from the spot, where it was introduced, into lymphatic glands, but has gained entrance to the blood, and

has affected the constitution. These evidences are called the **secondary symptoms** of syphilis, or briefly **secondaries.** The first of these is the appearance of a rash on the skin, which comes out in from six weeks to three months after infection, usually in about sixty or seventy days. The rash is at first of rosy red spots, which appear about the chest and belly, and may cover the whole body like a crop of measles. They soon become dull red or brown, and finally disappear, to be succeeded by pimples, which have a coppery colour. The pimples by and by fade, leaving copper-coloured stains in the skin, which take some time to disappear, but leave no scar. They begin on the trunk of the body, but spread to the arms and legs, and, unlike many ordinary skin affections, do not miss the palms of the hands and soles of the feet. They may come out in crops, off and on, for several months. Moreover, this rash of syphilis is capable of assuming many various forms; but, whatever the form, one great peculiarity is the coppery colour of the staining of the skin which attends it. The skin of the scalp is often affected, scales forming; and the hair loses its gloss, becomes dry, and tends to fall out, so that baldness may be produced.

Some amount of feverishness, loss of appetite, paleness, weakness, headache, and rheumatic like pains, often very severe, are not uncommonly experienced just before the appearance of the rash.

On page 307 it is explained that mucous membranes, the covering of red parts like the lips, inside of the mouth, throat, &c., are practically of the same structure as the skin. Hence it is not surprising that affections of the mucous membranes occur similar to those of the skin. The mouth and throat commonly suffer; the tonsils (p. 136) are liable to ulcerate, the nostrils and box of the windpipe sharing in the trouble. Raised patches about the corners of the mouth and anus (p. 130) are frequent.

Now it is certain that the matter that oozes from, or covers, these ulcers and raised patches, is capable of communicating the disease. This is a fact of the utmost importance to observe. What it implies is this, that a person who has such syphilitic ulcers or patches in throat or mouth, or tongue, is capable of communicating the disease by a kiss, if the slightest crack or fissure exists on the lip of the person kissed, by which the poison could enter. Moreover, for the same reason, a healthy person using without cleansing, cups, tumblers, &c., that have been just previously used by a syphilitic person may contract the disease. Thus while at the beginning of these paragraphs on syphilis it has been said that the disease is usually contracted by impure sexual intercourse, it is not uncommon to find it, in perfectly innocent persons, acquired by such other ways as have been indicated. For example, a hard chancre on the lip is often seen. A child who has inherited syphilis from its parents may communicate it to its wet nurse during suckling, and a wet nurse by the same means may communicate it to a child. Besides the affections of skin and mucous membranes, mentioned as secondary symptoms of the disease, others are common. Serious inflammations of the eye—inflammation of the iris and of the retina and optic nerve (p. 375)—are quite ordinary results. Affections of bones and joints, indicated by severe pains of a rheumatic character, usually worse at night, are also frequent. The bone affections are commonly marked by the appearance of small painful lumps, usually on the shin-bones, to which the term "nodes" is applied. In fact the diseases which may arise in the progress of the secondary stages of syphilis, due to the poison in the blood, are innumerable, and are only properly treated when their cause is recognized. This secondary stage lasts for from six to eighteen months, during which the general health of the patient is liable to serious disturbance and depression. At the end of that time the disease may disappear, even without treatment, and not again trouble the patient. Symptoms are, however, apt to show themselves now and again still indicative of the operation of the poison, such as the occurrence of skin diseases of various kinds, of ulcers, &c., which are obstinate, even refusing readily to yield to treatment.

Moreover, at a variable interval after the end of the secondary stage, what are called **tertiary symptoms** may reveal themselves. The chief evidence of the third stage is the formation of collections of inflammatory material in various parts of the body, in skin, mucous membranes, muscle, bone, liver, and other internal organs, brain, and spinal cord. These new growths are called **gummata.** These growths readily ulcerate and break down, causing destruction of the substance of the part in which they happen to be. They may disappear without ulceration, but still their disappearance is attended by destruction of the part in which they are lodged and consequent contraction of the part, shown by deep and permanent scars. In the skin the growths form flat elevated patches of a deep purplish-red colour, called

syphilitic tubercles. Such destructive growths may form in the gullet, leading to contraction and difficulty of swallowing, in the box of the windpipe, attacking the vocal cords (p. 262) and causing hoarseness and loss of voice, in the nostrils, producing destruction of the gristly parts, giving rise to offensive discharge (STINK-NOSE, p. 365), and ending in falling in of the bridge of the nose; and in many other parts may similar growths occur. Tumours may form in the brain, and may cause deafness, blindness, paralysis, and other symptoms dependent upon their position. Intense and persistent headaches continuing for weeks without intermission are extremely suspicious of syphilitic disease of the brain.

The consequence of such long-continued disease is a gradual but marked loss of general health and vigour, shown by sallowness of complexion and increasing thinness and loss of strength, so that the result of the disease is a miserable existence and a premature end.

Inherited Syphilis. A husband may, of course, infect his wife. Syphilis is a very common cause of abortion, occurring usually about the fifth or sixth month of pregnancy. One miscarriage after another may thus be occasioned, each succeeding one may be at a later period than the one before, till after several abortions a child is born alive. A child may be born with, already at birth, signs of the disease. It is shrivelled, puny, and unhealthy looking, and speedily dies. Commonly, however, at birth the child is healthy looking, and the signs of the disease do not appear till three or four weeks later. A syphilitic child has sores, chaps, and cracks at the corners of the mouth, ulcers of the mouth, and is afflicted with snuffles, owing to similar affections of the nostrils. Little soft growths are found about its anus (p. 130), and a rosy rash about the buttocks and neighbouring parts is a most common sign. It is peevish and fretful; its skin is dry and withered-looking, its face old and weird-looking, its hair scanty, its body thin and wasted. These symptoms, if the child live, disappear about the end of the first year, but scars are left to mark the seat of the sores. In later life the bridge of the nose is sunken, the teeth have a pegged appearance, and the clear part of the eye (cornea) is liable to suffer from an inflammation that makes it cloudy and of a ground-glass appearance.

A child may inherit syphilis from either parent; but a curious fact is that the child of a syphilitic father may exhibit the disease which the mother has escaped. The father may, that is to say, infect the child without previous infection of the mother.

Treatment.—It may be stated as a general rule that, if proper treatment be adopted early in the disease and persisted in, and *if the patient be a person of temperate habits, and, above all things, if he abstain from habits of drinking*, the disease may be got rid of within two years of infection. In regard to children it may also be said that, provided the disease does not appear for several weeks after birth, *and if the child be properly fed and in every way well cared* for, proper treatment will effect a cure.

The general treatment consists in good nourishing food, moderate exercise, moderation in, indeed abstinence from, all liquors, perfect cleanliness, and moderate exercise in the open air. Frequent washing of the whole body with soap and water, and an occasional Turkish bath are of importance. Flannel should be worn next the skin, and care to avoid chills taken. The patient should continue his work or business to give mental occupation. Smoking should be entirely given up if the mouth or throat is ulcerated, otherwise it should always be moderate.

As regards special treatment, a brief statement may be given of the treatment of an ordinary case in its different stages; but wherever possible the patient should place himself in the hands of a qualified physician, and should scrupulously follow his every direction. As regards the chancre, it is doubtful whether any treatment by burning, &c., will destroy the risk of the constitutional disease arising. The sore readily heals if cleanliness and frequent bathing are practised. If the patient is anxious to have it destroyed, caustic should not be used, but strong nitric acid. A brush, moistened with the acid, is lightly brushed over only the crack or ulcer, sound skin being avoided, and the sore is then bathed with cold water. A healthy sore remains, when the slough, due to the burning, separates. It soon heals if kept clean by bathing. Often the secondary symptoms appear before the patient is aware of having contracted the disease, the chancre having been unnoticed. When they appear, or to avoid them, if the chancre has been observed, the drug employed is mercury. Mercury has gained a bad reputation, because in former times it was improperly used. When properly used it is perfectly safe, and it is the only drug that can satisfactorily deal with the disease. When required when the secondary symptoms are slight, or used as a precaution, it may be given

in pill according to the following prescriptions:—

Blue Pill, 1 grain.
Extract of Gentian, 1 grain

to be made into one pill. One such pill is to be taken after meals thrice daily. It is well, before taking the first pill, to clear out the bowels by a double strong seidlitz-powder. If the mouth and gums become sore the pill is to be taken less frequently—twice daily, for example—or its use may be stopped for a day or two and then resumed after another purge. If treatment is not begun till the secondary symptoms have lasted for a time, such as sore throat, skin eruption, &c., the following mixture may be employed instead of the pills:—

Bichloride of Mercury, ...2 grains.
Chlorate of Potash, ...60 ,,
Water,..............................to 8 ounces.

Of the mixture a dessert-spoonful in water is taken thrice daily after meals.

If the above treatment by pills is adopted as a precaution only, it should not be stopped after several weeks because no symptoms have appeared. It should be continued for at least six months, and preferably twelve months, though not necessarily continuously. It may be stopped for a few days at a time and then resumed, and if after four or six months no symptoms have appeared, the dose may be reduced to two pills daily. Where the secondary symptoms have appeared the treatment *must not be dropped* simply because the rash on the skin has disappeared, the throat become well, and the health has apparently been restored. It ought to be persisted in for twelve months, and beyond that if symptoms still exist. If symptoms have ceased long before the twelve months have passed, the medicine may be stopped for short intervals and then resumed, and smaller or less frequent doses employed. Six months must pass, during which the person is free of symptoms, before the person can be pronounced cured.

In the third stage of the disease the drug used is iodide of potassium in 3-grain doses, dissolved in water and taken twice daily. It is well, in ordinary cases, after ceasing the use of mercury to use the iodide for several weeks. Iodide of potassium has a marked effect in the nervous troubles of the third stage. Thus for the continuous intense headache a dose of 10 grains may be given to begin with three times a day. The dose is daily increased by 3 or 4 grains till the person may be taking even 90 grains a-day, or till the headache ceases, when the dose is gradually brought down; but the smaller dose is to be persisted in for months. Sarsaparilla in dessert-spoonful doses may be given with the iodide. It helps the patient to bear the latter drug.

Great benefit is derived from a course of treatment at sulphur baths, such as Aix-la-Chapelle.

There are some people who cannot bear either mercury or the iodide, but it is impossible here to consider exceptional cases.

Ulcers and other sores may be bathed with a wash containing, to each ounce of water, 2 grains of sulphate of zinc.

For children a flannel bandage should be made to fit round the belly. On the surface next the skin a piece of mild blue ointment of the size of a pea should be smeared nightly. The movement of the flannel rubs it into the skin, which should be washed every third day. By the mouth syrup iodide of iron, a third of a teaspoonful, should be given thrice daily. Cleanliness and good milk are essential.

The extremely contagious nature of the disease has been pointed out. It is, therefore, scarcely necessary to say that a syphilitic person should abstain from sexual intercourse, from all contact, indeed, with others. It is probable, however, that in the third stage the contagiousness is not marked.

As regards marriage, it is almost a crime for a syphilitic person to marry before a year has elapsed without any sign of the disease. A person who has passed through the disease, and has been properly treated, should, therefore, not marry till three years have passed from the time of infection.

Cerebro-spinal Fever (*The Black Sickness* (popular name in Dublin)—*Spotted Fever*).—This is a fever which is probably contagious, and certainly occurs in an epidemic form. It is rare after forty years of age, and is not uncommon among young children. The symptoms are due to inflammation of the membranes of the brain (p. 91) and spinal marrow.

Symptoms.—The disease may begin with feverishness, headache, pains in the back and limbs, and feelings of illness lasting for a few hours or a couple of days before any serious disease is feared. Usually, however, the attack is sudden, coming on with collapse and insensibility or with severe shiverings (rigors), intense headache and dizziness, excessive pain in the back of the neck and along the spine, constant vomiting, pain in the stomach and cramping

of the muscles of the legs. The fever is not necessarily great, but the patient is restless and delirious or drowsy. The skin is over-sensitive, so that slight touches give rise to complaints of pain. One marked symptom is a stiffening of the muscles of the head and back, so that the patient's head and neck are arched back. A rash of blebs (*herpes*) appears on the lips. Purple spots (*petechiæ*) come out about the second day, in severe cases within the first twenty-four hours. They appear first on the legs. Purple blotches also appear over the body in very severe cases. Death may occur from collapse within a few hours of the attack, or from the first to the seventh day, the patient passing into stupor and from it to death. Death may not occur for several weeks, and may then be due to complications. Paralysis is a common complication and so also are affections of eyes, ears, and joints.

Even in favourable cases the illness lasts from two to six weeks, the extreme weakness that results being a cause of the delay.

Treatment.—If the attack begins with collapse, it must at first be met with the application of heat to the limbs and over the heart, and the administration of small quantities of stimulants. Mustard plasters over the chest and back are also recommended. When this stage is over, the intense pains in the head and back are relieved by ice bags on the back of the head and along the spine. For the same purpose opium given every two or three hours in 25-drop doses, as long as it appears safe, is recommended. *This must only be given to adults. Opium must never be given to children without express medical orders.* To them bromide of potassium in 5-grain doses every two hours may be advised.

Small quantities of strong beef-tea, and similar fluid nourishment, are to be given frequently.

At a later stage of the disease 3-grain doses of iodide of potassium may be given every four hours to aid in the removal of the inflammatory material poured out on the brain. To children the dose should begin at 1 grain.

The disease is extremely fatal, often within the first twenty-four hours owing to the nervous disturbance. Energetic treatment at the outset might relieve the brain, and therefore no delay should be permitted to occur in seeking skilled advice, wherever possible.

NON-INFECTIOUS FEVERS.

Ague (*Intermittent Fever—Marsh Fever—Malaria*).—Ague or intermittent fever is not a disease that may be communicated from one person to another. It is, nevertheless, a fever which is apparently due to the introduction of some poisonous agent into the body. The poison, called **malaria**, is bred in marshy places, where the energies of the soil are not used up owing to want of cultivation. Two conditions are apparently necessary for making a tract of land malarious: one is that for a season the land must be soaked with water which has no regular and sufficient outlet; and the second is that, following the period of soaking, a period of drying occurs, during which, under the influence of a hot sun, the land becomes dried up for some distance below the surface. It is during the latter period that the poison of malaria is produced, and that the region becomes unhealthy. Thus ague-districts are more common in countries where periods of drought regularly follow rainy seasons.

Drainage and cultivation are certain methods of ridding a district of malarious characters. In regions where ague and similar marsh fevers are common the poison rises from the ground with the vapours given off from the ground. In consequence, the poison is more abundant in the atmosphere nearer the ground, and is in diminished quantity in proportion to the height above the ground. So marked is this, that in ague-districts the upper stories of houses are more healthy than the ground-floors. The poisonous vapours may, however, be carried by air-currents up the sides of mountains in the immediate neighbourhood of the ague-districts, and by the same means may be conveyed to some distance beyond the place where they have been produced. The intervention of a considerable surface of water, such as that of a lake or river, will greatly prevent such conveyance; and a thick belt of trees has a similar effect.

One attack of ague, instead of protecting against a second, renders a person more liable to renewed attacks from the least exposure to the poison. Moreover, one who has suffered from ague is liable to other attacks even without being again exposed to the action of malaria.

Fever may appear in persons within a day or two after the reception of the poison, while others may have been removed for months from the malarious district before evidence of their having become affected by the poison presents itself.

Symptoms.—The feature that marks marsh fevers is that there are several attacks of fever separated from one another by intervals, during which the sufferer appears comparatively well. In its progress the fever has three well-marked

stages: the cold stage, the hot stage, and the sweating stage, following which is the period of the intermission, as it is called, in which the fever is completely absent. This period lasts for a variable time, and is succeeded by a second attack of the fever, going through the same stages as the first, ending in an intermission, followed by another attack, and so on. In one case the interval between the beginning of the first attack and the beginning of the second is only twenty-four hours. There is, in this case, a renewed attack of fever daily. This form is called **quotidian ague.** In another form, from the commencement of the first attack to that of the second is forty-eight hours. That is to say, there is a renewal of the fever every other day. This is called **tertian ague.** In a third form, the fever is renewed the third day from the beginning of the previous attack. This is **quartan ague.** In other cases the fever returns every fourth, fifth, or sixth day.

For some time before the disease actually attacks, the person may complain of weariedness, loss of appetite, headache, and pain in the back, or the disease may begin suddenly.

The *cold stage* is marked by a feeling of coldness; the person shivers; his teeth chatter and his limbs tremble violently; the face and hands are blue with the cold; and the skin is shrivelled and presents the appearance of "goose-skin." There is uneasiness about the stomach; headache and pains in back and limbs are present. Much very clear water is passed, and frequently. This stage may last from half an hour to several hours. The cold is only apparent, for if the temperature be taken with the thermometer (p. 10) it will be found already above the usual height.

The *hot stage* comes on gradually with the disappearance of the pinched and blue appearance of the skin. From feeling comfortably warm the patient becomes intensely hot, the face being flushed, skin dry and harsh, pulse full and frequent, and thirst being great. The person becomes restless, and sometimes slightly delirious. The headache is severe; and the sickness continues. This stage lasts from one to four or five hours, or even longer.

The *sweating stage* begins with the appearance of beads of perspiration on the face and brow. The hands and skin begin to get moist, and the person feels more comfortable. Soon copious sweating breaks out all over the body. The fever falls and the pulse becomes slower and softer. The breathing is less hurried than in the hot stage. Soon the fever is quite gone, and the patient comparatively well, but tired and inclined to sleep. The average length of the whole attack is from five to six hours, but it may be prolonged for double that time. In some cases one or other of the stages may not be well marked.

After a varying time a second attack comes on, as already noted, which goes through a similar course.

There is no definite time when the whole illness will pass away. But a person who has suffered from ague is always liable to renewed attacks on the slight provocation of a cold, indigestion, &c.

Persons who continue to reside in a malarious district, and who suffer from periodical attacks, gradually pass into a chronic state of ill-health, marked by a peculiar sallowness of complexion. Serious changes occur in the blood, liver, and spleen, producing a condition of poverty of blood and a tendency to dropsy, jaundice, and various other affections.

Treatment.—The treatment of ague is naturally twofold: that of the attack and that of the intermission. During the attack little can be done except in the way of making the patient as comfortable as possible. From the nature of the disease it is needless to attempt to arrest its progress. During the cold stage, therefore, the use of a plentiful supply of warm coverings, hot drinks, hot-water bottles, &c., will be grateful to the patient; and so, on the other hand, will be light coverings, a cool atmosphere, and tepid sponging of the body during the hot stage. It is during the period of absence of fever between two attacks that medicine must be administered to ward off, if possible, a new attack. The medicine to be given is quinine. Ten grains should be dissolved in water, to which a drop or two of tincture of steel have been added to aid the solution, and this dose given at the end of the sweating stage. It is to be repeated in four or six hours. After each renewed attack the quinine is to be administered in this way, and after the fever has ceased to return, the use of a daily dose of quinine must still be persisted in for a week or more. Nourishing foods should be administered, and to aid in the restoration of strength 30 drops of Easton's syrup (syrup of quinine, iron and strychnine) should be given in water thrice daily before food.

Whenever possible a person attacked by ague should be at once removed from the marshy district.

The prevention of ague is best accomplished by efficient draining and cultivation of the

district where it occurs by the clearing of jungle, and by similar means. The exercise of great care may enable one, compelled to live in a malarious district, to evade the disease. The person should sleep in the upper part of the house, should avoid going out late in the afternoon and early in the morning; all water should be filtered or boiled before use; excessive fatigue should be avoided; and quinine should be regularly taken.

Whenever a person, from repeated attacks of the fever, has become constitutionally affected, nothing should be allowed to prevent removal from the malarial situation to a healthy climate for a prolonged period.

Remittent Fever (*Bilious Remittent—Jungle Fever*) is a form of ague, but more severe in its symptoms and of a much more fatal tendency. It is due to the same cause as ague, and presents similar symptoms.

Symptoms.—The disease has its cold, its hot, and its sweating stage like ague. The cold stage is, however, very short, and hardly recognizable. The fever of the hot stage is very high, and this period is prolonged, lasting from six to twelve hours. The vomiting which occurs is violent and distressing. The material vomited up is first colourless, then bilious and sometimes bloody. The sweating stage is not so marked as in ague. With it the fever diminishes and the other symptoms improve, and the *remission* occurs, which differs from the interval of ague in the important fact that the disease does not disappear for a time as in ague, but simply abates to renew its violence in a short time—from ten to twelve hours. The remission usually occurs in the morning, and the fever is at its height at midnight. Day after day the attacks recur, usually at first with increasing severity. The illness lasts from five to fourteen days, and a favourable termination may be expected when the remissions are distinct and last for several hours.

Treatment is similar to that of ague. It is said to be well to begin with a purgative as soon as the disease manifests itself, and to an ordinarily strong adult 3 to 5 grains of calomel, the same of compound extract of colocynth and of powder of scammony, with 5 grains of quinine are advised. In the absence of these separate ingredients, one blue and one compound colocynth pill with 5 grains of quinine form about the same dose. No more medicine is to be given till the first remission, when 10-grain doses of quinine must be administered as advised for ague. If the person cannot retain the quinine on the stomach it should be carefully injected into the bowel (see ENEMA). To relieve the sickness, small pieces of ice should be given to suck, and warm cloths are applied over the stomach. When the fever remits, nourishing food is necessary, and if the exhaustion is great stimulants in repeated very small quantities. The other directions given under Ague apply equally to Remittent Fever.

Rheumatic Fever (*Acute Rheumatism*).—Acute rheumatism is a disease accompanied by very high fever, and attended by characteristic joint pains. The tendency to the disease runs markedly in families; and previous attacks increase the liability of a return. It affects mostly persons under the age of thirty. Exposure to colds, chills after overheating, &c., are frequent causes.

Symptoms.—The disease usually appears with signs of an ordinary attack of cold, such as a general feeling of illness, loss of appetite, sore throat, disturbed sleep, pains in the bones, feverishness, &c., the signs of what is commonly called an influenza cold, symptoms described under catarrh (p. 154). The chief signs of the fully formed disease are, high fever, pains in the joints, and severe sweats. The joints attacked are usually the larger ones, ankles, knees, wrists, shoulders, and elbows. The joints are not attacked all at once, but one after another as a rule, one joint getting well when another is becoming more painful. The pain is often excessive, so that the person lies straight and motionless in bed, afraid even of the slightest shake to the bed. The affected joints are hot, tinged with redness, tender to touch, and swollen. When the swelling has fallen, and the pain nearly gone, a feeling of stiffness remains. The muscles are also affected, and liable to painful twitchings. After the pain has begun in a joint, it increases till it is very severe, and then gradually dies away, the swelling disappearing with it. However much the joint may be swollen, matter is practically never formed in it. During the illness the whole body is bathed in sweat, which has a peculiar sour smell, easily perceived by everyone who comes near the patient. The sweats continue throughout the disease, and gradually pass off with recovery. The fever is often so high as itself to threaten life. In addition to these symptoms the tongue is white, appetite bad, bowels irregular, and pulse fast (120 per minute).

While these are the usual signs of a regular

attack, the disease may occur in a much milder form, with slight fever lasting only a day or two, only one or two joints being affected. In many such cases the disease frequently returns.

The length of the illness is never very definite, varying from two to six weeks or longer, but when the patient is properly attended to the severe symptoms should not last much beyond nine days. Recovery of strength is, however, slow. Death from the rheumatism itself is not common. But in the train of rheumatism are a great many other diseases, especially heart disease (namely, valve disease of the heart (p. 239), and inflammation of the pericardium (p. 238)), inflammation of the lungs and air tubes, and various others. Indeed the great risk is that of affection of the heart.

Treatment.—The patient should be in an open bed lying between blankets. The affected joints should be kept at rest. An aid to this is obtained by wrapping them in cotton wool, secured by a flannel bandage. The principal medicine now given is salicine or salicylate of soda. It is administered in 20-grain doses in water every two hours for twelve hours or so, when the pains are generally relieved and the fever falls. Thereafter the powders are repeated every three or four hours or at longer intervals. The evil of the remedy is that it frequently produces deafness and unpleasant noises in the ears, and sometimes sickness and faintness. In spite of the noises in the ears, &c., the powders should be persisted in if necessary, as the unpleasant symptoms attending their use will pass away in a few days. But if sickness or faintness arise a more sparing use of them must be made. It is marvellous how quickly in many cases this treatment relieves. When it does so, the dose should be continued twice or thrice daily for several days after the fever has passed away. Then a quinine and iron tonic should be given, and great care must be taken for some time to prevent a relapse. Sometimes this treatment fails. In such a case the old treatment with potash must be resorted to. Thirty grains of acetate of potash are to be given every 3 or 4 hours. At bed-time 10 grains (*to an adult*) of Dover's powder will relieve pain and help sleep. Quinine and iron tonics are also necessary after the fever has passed. Throughout the illness nourishing, easily digested foods are to be given *in small quantities* frequently repeated. Milk and milk puddings, thin mutton broth, &c., are best, but no butcher meat should be allowed till recovery has taken place. Soda water and milk is a grateful drink to the patient. The bowels also require attention, an ordinary purgative medicine being given as required.

Though the treatment has thus been mentioned in some detail, it is needful to say that no case ought to be without medical supervision, unless that is absolutely unavoidable. A physician will often detect commencing affection of the heart, and take steps to prevent it if possible. Neglected cases too often end fatally in time because this evil has not been guarded against.

Chronic Rheumatism, as it affects the joints, is discussed on p. 33.

Section XIV.—SOME GENERAL DISEASES.

TUBERCULOSIS AND SCROFULA. GOUT. CANCER. DROPSY.

TUBERCULOSIS AND SCROFULA.

Tuberculosis is the term applied to a general disease, due to the formation of tubercles in various organs of the body. The nature of tubercles has been shortly explained on p. 165, and at greater length on p. 278, but to give a complete idea of the disease, the chief points of these explanations may be again mentioned. A **tubercle** is a little nodule, grey in colour, about the size of a millet seed, consisting of a collection of round cells. It is to be considered as a new growth, foreign to the part in which it is present. The little nodule tends to increase in size by the growth of others round it. By its growth it destroys the substance of the part in which it is placed, occasioning also inflammation in the surrounding parts. It has no great vitality, and undergoes changes, which begin in the centre of the nodule, the result of which is to convert the firm grey mass into yellow cheesy material. The process may go on till the nodule becomes quite broken down into soft matter, and, if the matter can break out from the part, an ulcer is left. Instead of softening, the nodule may become hard by the

deposit of lime salts in it, and become converted into a little solid mass in the substance of the tissue where it is lodged.

Now the effects produced by the formation of such tubercles depend on the organ or tissue of the body in which the diseased process is going on. In the general disease tuberculosis the formation of the grey nodules proceeds in most of the organs of the body—lungs, liver, kidneys, lymphatic glands, bowels, membranes of the brain, &c., and the symptoms produced are those of a fever, and strongly resemble symptoms of typhoid fever. This form of the disease may last two or three weeks, and its termination is death. The true nature of the disease it is extremely difficult to recognize during life.

On the other hand the formation of tubercles may be limited to one organ of the body, at least at first. Thus if the formation is principally in the lungs, it produces consumption (p. 277). In the bowels it produces consumption of the bowels (p. 105). The same process going on in the membranes of the brain is the cause of acute water-in-the-head (p. 101); and a similar tubercular deposit in lymphatic glands is believed to be the cause of the swelling and breaking down of the glands that are the main features of scrofula.

Recent investigations have tended to establish a relationship between the growth of tubercle and the activity of some peculiar form of germ. That tubercle spreads by contagion is evident. In cases of tuberculous consumption the throat is commonly affected by tubercular ulceration, so that the voice is hoarse and may be lost; and this is due to the contact of the spit from the lungs. Moreover, in such cases tubercular ulcers are usually found in the bowels, probably because the contagious matter is swallowed and the ulceration thereby extended. But definite experiments have conclusively proved the truth of the contagious character of the disease (refer to p. 393).

The tendency to tubercle is hereditary. No age is free from the possibility of an attack; but it is most common in early life.

It is needless to discuss the symptoms or treatment of the general disease, and the special affections of lungs, bowels, and brain have been considered elsewhere. Where the tendency to this form of disease is known to exist in families, much may be done to avoid its appearance. The general treatment is the same as that suggested for scrofula, which, as has been already indicated, is a manifestation of the tubercular taint.

Scrofula (*Struma—King's Evil*) is a constitutional condition in which the general health is much weakened, and in which there is a great tendency to slow inflammation of various parts of the body and to the formation of abscesses and ulcers slow to heal. (The disease was called King's Evil from the idea that it could be cured by the king's touch.) It is a condition occurring in families and descending from parents to children. The organs of the body specially apt to suffer are the lymphatic glands, which become enlarged, softened, and readily break down, becoming converted into cheesy material. When it is the glands about the neck (p. 208) that are specially affected, the disease is evident, but other glands deep-seated and not within reach of examination are equally prone to the affection, which may, therefore, not be so evident. Scrofulous persons are often in early life of a pasty complexion, pale and flabby, with sluggish circulation, stunted in growth, with short narrow chest, and prominent belly, and soft muscles. Others again are of bright fair complexion, with light red hair, and are unusually bright and clever. Many children, though apparently scrofulous, gradually grow out of this condition and become vigorous men and women.

While inflammation and formation of matter in the glands are the popularly known signs of the scrofulous condition, many other organs of the body may be the seat of scrofulous disease. Thus some kinds of inflammation of the eyes are essentially scrofulous; scrofulous diseases of bone and joints are common; chronic eruptions and ulcers of the skin, discharges from the ear and nose, are also frequently the result of the bad condition of health. Consumption of the lungs or bowels may arise from the same general weakness.

Scrofula is believed to be a manifestation of tubercle, discussed above, and the breaking down and suppuration of glands, the distinctive feature of scrofula, to be the result of the deposit within the glands of tuberculous matter.

Treatment.—Nothing so much aids in the progress of a scrofulous tendency than bad food, bad air, want of cleanliness, and the absence of opportunities of healthy exercise, and nothing is so effective in removing the disposition to the disease than the removal of these evils. A scrofulous child should be regularly bathed; it should be clothed in flannel. Plenty of fresh air and sunlight are absolutely necessary. Nothing is, consequently, so valuable as a change from a close town to the sea-coast. Moderate sea-bathing is very useful. If this cannot be ob-

tained, the child should be bathed at home daily in a bath containing Tidman's sea-salt, and should be vigorously rubbed afterwards. Food is to be liberally allowed, especially sweet milk, eggs, soups, &c. Cod-liver oil is the chief medicine, and should be given for a long period, indeed long after health appears quite re-established. Most children learn to like it. Small doses should be given at first, half a tea-spoonful twice daily, and the dose should be gradually increased till a dessert-spoonful or a table-spoonful is being taken thrice daily. To those who, after patient trial, cannot get over the taste of the oil, malt extract or malt extract and cod-liver oil may be given. Another valuable medicine is iron, given as dialysed iron (4 to 10 drops (according to age) five times daily in water), or as syrup iodide of iron (a half to one tea-spoonful thrice daily), or as Parrish's syrup of the phosphates, commonly called chemical food, given in a half to one or two tea-spoonfuls thrice a day. The cod-liver oil and the iron tonic may be given at the same time.

Glands that have become swollen and painful ought not to be rubbed, nor irritated in any way (see p. 209). The oil and the syrup of iodide of iron ought to be persevered with, and the neck simply protected by a strip of flannel. Frequently the affected glands will recover under this treatment if not worried into suppuration. If, however, matter forms in the glands, the sooner a surgeon opens them the better.

GOUT.

Gout is a markedly hereditary disease, descending from parents to children in a very remarkable way. Men are more frequently attacked than women; the age most liable to the disease is between thirty and forty-five. The circumstances that usually determine an attack in those liable by inheritance to the disease, or that excite the disease for the first time, are habitual excess in eating, specially in the over-eating of animal food and rich dishes, long-continued excess in drinking, especially strong wines, such as port, sherry, madeira, and malt liquors (beer and porter), and prolonged want of proper exercise. It appears also that persons subject in their occupation to the influence of lead are rendered more liable to an attack, if other circumstances favour it. It appears that the disease is due to an excess in the blood of a substance called uric acid, either because it is formed in the body in too large quantity, or because it is not removed from the blood by the kidneys in the urine as it ought to be. It is a disease specially apt to return frequently, very slight causes being sufficient to determine an attack in those subject to it. Thus even a slight degree of indigestion, irregularity of bowels, cold, mental anxiety or worry or excitement may occasion a fit of the gout in gouty persons.

Symptoms.—An acute attack of gout usually comes on suddenly during the night with pain and swelling in a joint, commonly the joint that forms the ball of the great toe. The joint becomes not only much swollen, but also turns red and shiny, the veins on the foot and part of the leg being very marked. The pain is often extremely severe, and is burning or shooting in character. Other joints may also be attacked, the smaller ones specially. The least movement is almost unbearable, and even the weight of the bed-clothes is not endurable. Towards morning the pain lessens, but next evening it returns, and this may continue for a week or ten days, when the severe symptoms pass away, though the joint remains swollen and tender for some time longer. However swollen the joint may be, matter does not form. Attending the joint affection there are general symptoms of disturbed health, shiverings and sweatings, loss of appetite, white tongue, increased heat of skin, quick pulse, confined bowels, and scanty high-coloured urine, from which a brick-red deposit separates out on cooling. The sleep is much disturbed; cramps and startings of the muscles of the leg are common; and the patient is of very irritable temper. After the first attack the joint apparently quite recovers. As a rule the disease returns sooner or later, generally within a year; and not only does it tend to return, but the intervals between each "fit" become shorter. With the greater frequency of attack, more joints are liable to suffer—joints of foot, hand, ankle, knee, &c. As the disease becomes chronic the joints become permanently altered. They enlarge, and deformities are produced, due largely to the deposit within the tissues of the joint of masses of urate of soda, called "chalk-stones," which not only form prominences and irregularities, but by being deposited around the joint tend to fix it in unusual and awkward positions. Abscesses may form round the chalk-stones, from which they may be discharged, leaving ulcers. The general system tends to become affected and the person to grow feeble and weak.

Those who suffer from attacks of gout are often warned of an on-coming "fit" by symptoms not well marked, but which, by experience, they know too well the meaning of. Those

symptoms may be connected with the digestive organs—flatulence, heartburn, irregularity of bowels, or connected with the heart, such as palpitation; or there may be headache, irritable temper, and various other nervous symptoms.

There are forms of **irregular gout** that show themselves by severe stomach disturbance, such as acute spasmodic pain or cramp and bilious vomiting, or by disturbance of the heart, evidenced by palpitation, faintness, &c. By similar attacks of irregular gout the breathing may be much disturbed and rendered so laborious that suffocation seems to threaten. Nervous and other symptoms may also be due to a similar cause.

Treatment.—Very strict regulation of the habits of life is one of the most important elements in the treatment of gout. The person must exercise great restraint in eating, and must take no more than is necessary for proper nourishment. A mixed animal and vegetable diet is the best, but the amount of animal food in particular must not be in excess. Of this class of food the best kinds are white fish, game, fowl, and mutton. Fat meat such as pork, salted and spiced meats, and all rich dishes are to be avoided. In regard to vegetables, some believe in the free use of celery. Stewed fruits are allowed, but no pastries, and the fruits should be sparingly sweetened. Extreme moderation in drink is absolutely necessary, beer, porter, and rich wines, champagne included, being rigidly abstained from. Such wines as hock, moselle, claret, alone are safe; whether they should be used at all, and, still more, whether any whisky or brandy may be taken, ought to be left to the decision of a medical attendant. Water should be the principal drink. Tea and coffee are not necessarily harmful. Potash, soda, and lithia water, may do much good, and ought to be taken freely, but only between meals.

The gouty person should take regular outdoor exercise daily, and should go early to bed and rise early. The clothing should be warm. Baths are of great use, and specially a well-ordered Turkish bath. Exposure is to be avoided; and sudden changes of temperature are to be guarded against. For this reason, where a choice can be made, an equable climate is to be preferred. As regards treatment during an acute attack, it should be begun with opening medicine, such as rhubarb (10 grains) and bicarbonate of soda (15 grains), the dose being repeated as found necessary. To relieve the pain the drug most extensively used is meadow-saffron or colchicum. The preparation used is the wine, given in water in 10 to 30 drop doses every four or six hours along with 6-grain doses of citrate or carbonate of lithia or potash. The use of the colchicum may be continued for several days if it agrees with the patient. At the same time the action of the skin and kidneys is to be promoted by the patient being kept warm, and drinking freely of barley-water, soda-water, or cream-of-tartar water flavoured with lemons. The food should be light and nourishing—milk and bread, a little beef-tea, &c.—and rather spare in quantity. The affected joint should be kept at rest, supported in a raised position, and surrounded by a piece of flannel dipped in warm water, and covered by cotton wool.

In chronic cases 3 to 6 grains of carbonate of lithia should be taken twice daily in a wine-glassful of water, and Carlsbad or Vichy water largely used.

CANCER.

Cancer (Latin *cancer*, a crab—*Carcinoma*).—The name of this disease is derived from the appearance of the part attacked by the disease, as it struck the ancients, the veins surrounding the diseased part resembling a crab's claw.

Cancer is considered in this section more as a matter of convenience. It is still a question much discussed whether cancer ought to be counted a local or a constitutional disease, and many reasons can be adduced for answering the question either way. It is certain, however, that after cancer has appeared in any part, however small and limited its position may be, and however insignificant it may appear, it will in time spread along various channels and affect the whole system.

Nature.—Its character is that of a tumour, swelling, growth, or deposit, which tends to spread, not simply by becoming larger and squeezing aside the healthy substance of the part in which it is placed to make room for itself, but by growing into the healthy parts, invading them, and incorporating them into itself. It can never, therefore, be removed from its position as a whole without other parts being disturbed, but if removed the whole mass of tissue in which it is placed must be cut out with it. Moreover, even if removed, it tends sooner or later to return, perhaps just because it so invades the tissues that it is impossible to make sure that all of it has been removed. This feature of it is one of the chief reasons why it is called "malignant." For it is evident that a tumour, whose tendency is always to return to the attack, is likely some day to overcome its

victim. A "simple" tumour, however, is one which, once removed, is done with. Not only does cancer tend to spread by direct invasion of the substance of the part where it is placed, but it also tends to spread to distant parts by conveyance along vessels. Blood-vessels are doubtless channels along which particles of cancerous material may be carried to parts at some distance from the original growth, and which, taking root in the new situation, proceed to grow and form a secondary tumour. Other channels, which afford an even readier means of transit, are the lymphatic vessels, which, as has been noted on page 200, are found in every tissue of the body as drains for the removal of excessive nourishment supplied to the part, and also for the removal of waste products. Into these channels, therefore, juice and particles from the tumour will find their way. The lymphatic vessels pass to lymphatic glands in order that the material they carry may be worked up into a fit state for return to the blood. Thus it is that some time after a cancerous tumour has appeared in some part of the body the glands in the neighbourhood are almost certain to be found enlarged and otherwise affected. It is this that renders it so difficult to remove a cancerous growth with any certainty of permanent cure. For the cancerous material may have been carried considerable distances from the original tumour by such channels, without any signs of the transference being evident for a long time. It is this also that renders it imperative that a cancerous growth should be remorselessly cut out as soon as it is discovered, and the smaller and more insignificant the growth appears the more eager should the patient be for its removal. But it is just at this stage of its growth that patients are indisposed to permit an operation. It is so small, or it gives so little perhaps no trouble, what is the need of operating at present? Wait till it is bigger, painful, troublesome, then the patient will consent. It is necessary earnestly to insist on the undoubted fact, the reasons for which have just been given, that it is while the growth is small and trifling that its removal is most hopeful, and that waiting till it is bigger means practically waiting till it is hopeless.

As to the nature of the growth itself, cancer is essentially formed of a degenerate kind of cell, and is originally connected with structures mainly of the epithelial type (see p. 16). Thus the surface layer of the skin consists of epithelial cells (p. 307), the mucous membrane of the mouth has a similar superficial layer (p. 136); the stomach and whole length of the intestinal canal (p. 140) has an outermost layer of cells; the membrane covering the windpipe and tubes of the lungs, as well as the air spaces of the lungs themselves, are covered with epithelial cells (p. 252); the kidney and bladder have similar inner coatings (pp. 290, 293), while glands, the salivary glands (p. 137), the glands of the stomach and intestine (p. 139), are also lined with epithelial cells. Now it is in these situations and others of a similar character that cancer is found, the cells coming under some degenerative influence, which causes them to multiply in enormous numbers and thus to invade the surrounding tissues and form deposits. The cells are held together by a small amount of connective tissue (p. 16), in whose spaces the cells lie. A cancer tumour is thus a growth formed of masses of cells in groups held together by connective tissue, the cells being originally derived from the natural cells of the part.

Varieties of cancer depend mainly upon the relative proportions of the cells and binding tissue, and of a fluid—the cancer juice—also present in the growth. Thus **hard cancer** or **scirrhus** has the binding tissue in greatest abundance, and forms a very hard tumour; **soft cancer, encephaloid** or **medullary cancer** contains more cells and is of a very soft consistence, growing also with greater rapidity than the hard variety; while **epithelioma,** or skin cancer, consists mainly of flat cells like those of the skin, or cells similar to those of glands, and occurs in the shape of an irregular ulcer.

Seat.—The position of the tumour may vary as already indicated. It may occur on the skin or on mucous membranes, like that of the tongue, lips, stomach, and other parts of the alimentary canal, in the bladder and womb, in glands, such as the salivary glands and breast, the glands of the intestinal tract, the liver, the testicle, the lungs, the eye, bone, lymphatic glands, nose, and many other parts. In fact it may occur almost anywhere. For even though it may originate only in epithelial structures, as already noted, it is easily transmitted to other parts, in which it could not begin, by the channels of the blood-vessels and lymphatics. In men a common seat of cancer is the lip, where it is of the epithelioma variety. In women the breast and womb are frequent situations, hard cancer being most frequently in the breast. Internally the stomach, liver, and lungs are common situations.

The **causes** of cancer it is not easy definitely

to state. Undoubtedly hereditary influence is great in many cases. Age has something to do with liability to the disease. The greater proportion of cases in men occur between fifty-five and sixty years of age, and in women between forty-five and fifty-five. It is twice as common in women as in men; and the liability seems to be greater in women who have borne children. These are of the nature of predisposing causes (see p. 4). Sometimes the occurrence of the growth seems to be determined in position by the presence of some long-continued irritation. Thus the irritation of a short juicy pipe, constantly smoked, has determined the appearance on the lip, and the irritation of a ragged tooth on the tongue, while cancer of the breast in a woman has followed at no distant time a blow on the breast. Frequently, of course, no such local cause can be suggested. It may be that with a constitutional tendency to the disease, it only required such an irritation to determine its occurrence.

The **progress** of the disease is slow or rapid according to the variety of the growth and its site, soft cancer being rapid in growth, epithelioma very slow. In its course the tumour continues growing for a certain time, and then it begins to break down, an irregular ulcer being formed from which a fœtid discharge proceeds. In time, sooner or later as the disease spreads quickly or slowly, and according to the speed with which it extends to other organs, the health suffers, and a constitutional state arises to which the term "cancerous cachexia" has been applied. The countenance is peculiarly pale and sallow, and the sufferer wears a very anxious and careworn look. The general surface of the body acquires a yellowish hue, the appetite is diminished, the strength gradually fails, and the pulse is weak. The patient complains of lassitude and of inability for exertion. Emaciation sets in, at last death ensues from exhaustion, or the combined effects of discharge, debility, and pain. Life may, however, be shortened more speedily owing to the interference of the tumour with the functions of some important organ, or to frequent attacks of bleeding from the ulcerating surface, caused by the disease opening into blood-vessels.

Symptoms of cancer it is impossible to discuss in detail. Those of cancer of the breast and the womb will be considered in the section on DISEASES OF WOMEN. As regards internal cancer, its presence requires for detection a skilful and experienced physician. Concerning cancer of the lip and tongue it is only necessary to say that the presence of a ragged ulcer, with hard base, from which a foul discharge proceeds, and which refuses to heal, is suspicious, and ought to cause the sufferer to seek early and skilled advice.

Treatment.—No drug will cure cancer. The virtues of one medicine after another have been lauded in vain. Time and more experience have shown the worthlessness of them all. The only treatment for cancer is removal, if that is possible. Caustics have been used to burn out the mass, and are occasionally used still, but removal by the knife is the preferable operation. This a surgeon will not undertake unless with a prospect of being able to remove the whole growth. It must, therefore, be done early, before the disease has invaded lymphatic glands and other organs. When it is too late to operate, the only treatment is one to relieve the symptoms, to support the strength of the patient and to alleviate pain. Each case must, however, be treated on its merits, and requires medical supervision.

DROPSY.

Dropsy is an accumulation of fluid which has oozed out from the blood-vessels in the minute spaces in the tissue, or in some of the cavities of the body, the cavity of the belly for example. It is called by other names according to the position of the accumulated fluid. Dropsy confined to the tissue under the skin, in the foot, leg, or arm, for example, is called **œdema** or **anasarca**. Dropsy of the belly is **ascites** (p. 191). The accumulation of fluid round the lung in pleurisy (p. 266) is a dropsy, and a similar collection round the heart is called **hydropericardium** or dropsy of the heart (p. 238). On p. 203 it is explained that fluid is constantly oozing from the finest blood-vessels into the tissues to nourish them, that more fluid oozes than is necessary, and that the excess is picked up mainly by lymphatic vessels, and afterwards returned to the blood. Now suppose more fluid escapes than can be picked up by the lymphatics, or suppose the absorbing vessels are somehow prevented fulfilling their purpose, the excess of fluid will remain and accumulate in the tissues, and in a short time that part will be the seat of dropsy.

Causes of dropsy are thus readily understood. The quality of the blood may be so altered that fluid passes out very readily and in great excess. This happens in anæmia (p. 234), and in Bright's disease of the kidney (p. 295).

Again where obstruction exists to the return of blood to the heart, the blood accumulates in the veins; there is greater pressure on the blood, causing more to pass out of the vessels, and preventing also its absorption, and so dropsy again results. This obstruction may be merely local. A tumour pressing upon the main vein of a limb will thus produce dropsy limited to that limb. In pregnant women the pressure of the enlarging womb on the veins frequently causes swelling of the legs. Dropsy may be more general. Thus in certain diseases of the liver the circulation is obstructed, and since all the blood from the belly and the lower limbs passes through the liver the obstruction is experienced in all these parts and dropsy of both legs and of the cavity of the belly will soon ensue. A more general cause even than this, and more common, is heart disease, where the onward movement of the blood is hindered by some valve affection (p. 239) causing accumulation of blood in the veins of lungs, liver, and other parts, and occasioning extensive dropsy. In such cases the parts at the greatest distance from the heart, and in the lowest situations, will feel the pressure of blood most, and will show the evidence of dropsical swelling soonest and most markedly, for example the feet and legs. The same condition may be produced even when no real affection of the valves exists, if the heart is so feeble that it does not contract with sufficient vigour to cause a steady and regular circulation of the blood. The walls of the heart, yielding too much to the pressure of blood within them, may stretch unduly, and thus the heart becomes dilated and thin-walled in proportion to the degree of stretching. Under these circumstances the circulation is sluggish, and in time the blood in the veins experiences a backward pressure, which causes an undue amount of fluid to pass out into the tissues, and dropsy ensues. In these circumstances the swelling appears first in the feet and legs. It must not, however, be thought that swelling of the feet and legs is in every case caused by something wrong with the heart. Many people are troubled with swelling of the feet and lower parts of the legs after standing long or going about a good deal, the swelling usually disappearing after a rest in bed. This does not necessarily imply any particular disease. When a person stands, the weight of the column of blood in the veins of the legs is considerable, and if the vessels be relaxed in any degree the vessels widen unduly, and the movement of blood is slower than usual, allowing a greater oozing of fluid than can be quickly removed.

In pleurisy, dropsy of the heart, and similar instances, the accumulation of fluid is due not to obstruction to the return of fluid, but to an active determination of a much greater than ordinary quantity of blood by the acute inflammation going on.

The **treatment** of dropsy depends on the cause. The cause should if possible be removed; the state of the liver should be corrected if possible, the weak heart strengthened, &c. Drugs are employed for the purpose of removing from the blood and casting out of the body a larger amount of water than usual, and so encouraging the picking up of the dropsical fluid into the current of the circulation. Active purgatives, which cause large evacuations of watery stools, do this, such as jalap and elaterium. Other drugs effect the same thing by promoting an increased flow of urine, such as nitre, gin, spirits of juniper, and digitalis. Profuse sweating by means of hot-air baths aids in a similar way. Digitalis is a very useful drug, since it both strengthens the heart and promotes the action of the kidney. It is in cases where the dropsy is due to some condition of the heart that digitalis proves most valuable. By its strengthening action on the heart it causes more vigorous contractions and tends to restore efficiency to the circulation. But the employment of these means is always attended with risk, unless used by those who really understand the cause of the dropsy and adapt the remedy with care to the circumstances of the case. Therefore the treatment needs determination by a physician.

When treatment by drugs fails the accumulated fluid is frequently drained off by tapping.

SECTION XV.—THE MANAGEMENT OF CHILDREN IN HEALTH AND DISEASE.

The Management of Children in Health.

The High Mortality of Children and its Causes:

The Management of the Newly-born Child:

Food—Its nature—Frequency of supply—Choice of a wet-nurse—Rearing by hand;

Bathing and *Clothing;*

Exercise, Air, and *Sleep;*

Use of Medicines;

Premature Children;

Vaccination.

The Management of Children between the Sixth Month and Second Year:

Food—Weaning;

Teething—Milk-teeth and permanent teeth—Their periods of cutting;

Bathing, Clothing, and *Exercise;*

Children's Apartments.

The Management of Children in Disease.

General Signs of Disease in Children:

General Treatment of Children in Disease:

Affections of the Newly-born Child:

Irregularities of Form—Tumours of head and back—Harelip and Cleft-palate—Blue Disease, &c.;

Diseases of Navel and Eyes; Jaundice of the Newly-born;

Swelling of the Breasts.

Diseases Common to Childhood:

Ailments at the Periods of Teething and Weaning;

Coughs, Colds, and Affections of the Chest—Cold—Bronchitis—Cough;

Affections of the Mouth, Stomach, Bowels, &c.—Thrush (Sprue)—Inflammation and ulcers of the mouth—Vomiting—Colic—Looseness of bowels—Infantile cholera—Intussusception—Cos tiveness—Worms—Falling of the bowel—Rupture—Bed-wetting;

Spasmodic Diseases—Convulsions—Night-terrors—Child-crowing—Water-in-the-head, &c.;

Fevers;

Scrofula and Consumption—The treatment of delicate children;

Skin Diseases—Tooth-rash—Red-gum—Scalled head—Running ears;

Rickets;

Accidents—Burns, Wounds, Sprains, &c.—Falls on the head—Bleeding at the nose—Choking.

THE MANAGEMENT OF CHILDREN IN HEALTH.

HIGH MORTALITY OF CHILDREN.

That there is need for spreading broadcast fuller knowledge than the public evidently at present possesses of the proper methods of dealing with children, both in health and in illness, is strikingly evident from the statistics carefully collected and detailed by the late Dr. Wm. Farr, of the Registrar-General's Office. The facts are so clearly given in Dr. Farr's own words in his annual reports that a few extracts will best show what they are.

"In England and Wales the deaths of 2,374,379 infants in the first year of age were registered in the 26 years 1838–63; and of the number 1,329,287 were boys, 1,045,092 were girls."

"Nearly 100,000 infants die annually, in the proportion of about 56 boys to 44 girls."

"Even in the healthy districts of the country, out of 1,000,000 born, 175,410 children die in the first five years of life; but in Liverpool district, which serves to represent the most unfavourable sanitary conditions, out of the same number born, 460,370, *nearly half the number born,* die in the five years following their birth."

That is to say, one in every six children born dies within the first five years of life, even in the healthy parts of the country, but in the unhealthy parts the proportion is one-half. Moreover, Dr. Farr showed that the majority of the deaths occurred *within the first year of life.* Thus "of 100 children born, 15 die in the first year, 5 in the second, 3 in the third year, 2 in the fourth, and 1 in the fifth; making 26 in the 5 years of age. Of the 15 who die in the first year, 5 die in the first month of life, 2 in the second, and 1 in the third."

Now what is the cause, or what are the causes of such a tremendous infant mortality? That question also Dr. Farr tries to answer. The

result is given in tabular form. In the three years 1873–75 the annual number of deaths, from all causes, of children under one year of age to every 1000 births was 278. The separate causes of these 278 are given in the table:—

Total number of deaths to every 1000 births,		278
Of which the number of deaths caused		
by premature birth and atrophy (wasting) was		70
,, lung diseases	,,	51
,, convulsions	,,	31
,, diarrhœa (looseness of bowels)	,,	24
,, tubercular disease	,,	21
,, whooping-cough	,,	12
,, teething	,,	6
,, measles	,,	4
,, scarlet fever	,,	3
		222

The causes of the remainder are not detailed.

Of the 278, no less than 125 were due to such diseases as atrophy (wasting), convulsions, and diarrhœa. Commenting on the table Dr. Farr says: "Some of the principal causes are improper and insufficient food, bad management, use of opiates, neglect, early marriages, and debility of mothers; but whatever may be the special agencies at work which are so prejudicial to infant life, it must be borne in mind that a high death-rate is in a great measure also due to bad sanitary arrangements." "*The causes of death which are more directly the result of neglect and mismanagement are convulsions, diarrhœa, and atrophy*," and again, "the causes most fatal to infant life in factory towns, and which are inseparable from bad nursing and feeding, are diarrhœa, convulsions, and atrophy."

It is to be observed that in this table the number of victims of measles and scarlet fever is small, but it is in the second, third, and fourth years of life that these diseases are worst, and not during the first year to which the table is limited. It seems that since 1875 a considerable decrease has taken place in the average English death-rate, a decrease affecting not only the adult portion of the population, but the infant portion as well. It seems plain that this improved state of affairs is due to the operation of acts of parliament referring to public health, to the greater care consequently taken to keep down and rectify, as far as possible, unhealthy conditions, to more vigorous measures in dealing with and preventing the spread of infectious diseases, and to other similar causes. But public health acts touch very little those great causes of infant mortality, noted by Farr, "neglect and mismanagement," which are still the chief causes of an unnecessarily high rate of infant death. These causes are not limited to particular classes of society, though they may be more strikingly evident in one class than in another. Mismanagement of children is certainly very common in every grade of society, and is as frequent a cause of childish ailments in the houses of the rich as in those of the poor. The first part of this section is, therefore, devoted to a consideration of the proper methods of managing children in health.

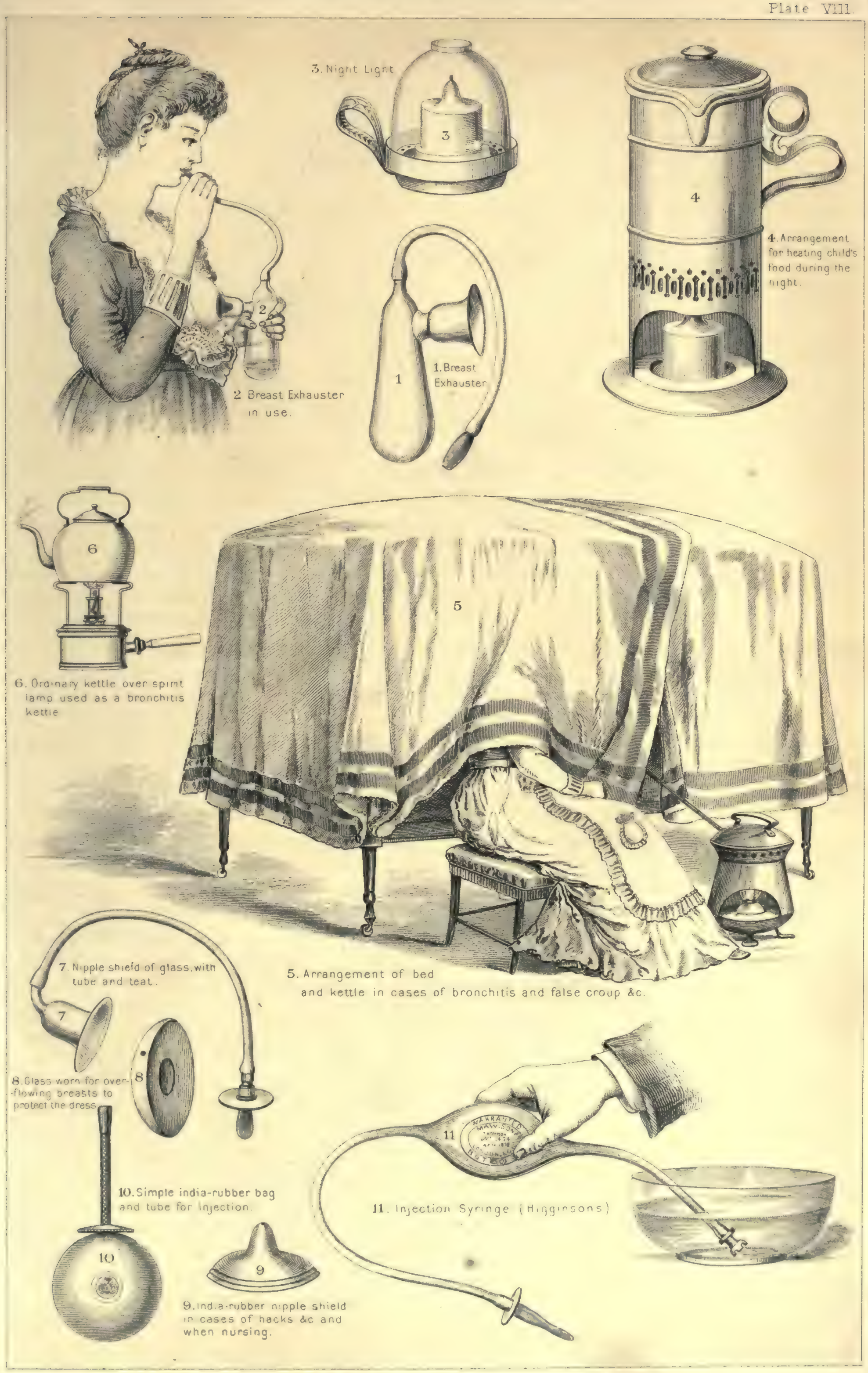
THE MANAGEMENT OF THE NEWLY-BORN CHILD.

Food.—From the day of its birth till it is four or six months of age the child should be nourished, in ordinary circumstances, *entirely* by its mother's milk, and during that period no other food of any kind whatever ought to be allowed. It is a mother's chief duty in relation to her child to suckle it, and neither her pleasure nor convenience should, for a moment, be allowed to come into consideration. A bad state of the mother's health may make it advisable, not for her own sake only but also for her child's, that the child should be otherwise reared, but this is the only valid reason as a rule.

It often happens that there is no milk in the mother's breasts for some hours after the birth of the child, and it is the custom of most nurses in the meantime to feed it with spoonfuls of sweetened water. This is entirely a wrong and unnecessary proceeding. There are few children that cannot afford to wait for twelve or even twenty-four hours. The proceeding is also hurtful, leading to irritation of the child's stomach, and the production of wind, colic, and other evils. In every case the child should be put to the mother's breast, immediately after it has been washed and dressed, if the mother is not too tired, and at latest within an hour or two after birth. It often needs the exercise of some little patience before the child obtains a proper hold of the nipple. It should be aided by the nipple being drawn out with the fingers and moistened with milk. If there is milk in the breast the child will obtain satisfaction, and will soon relax its hold and drop off to sleep. The nipple should be removed from its mouth and dried to prevent hacking. But if no milk has been in the breasts, some advantage is yet gained in the drawing out of the nipple, and in the stimulus which has been given to the gland to hasten its activity. Between two and a half and three hours after the last suckling the child must again be put to the breast, and this is the

NURSERY APPLIANCES.

Plate VIII.



proper interval between each period of suckling for the first ten days or a fortnight after the birth. Regularly as the clock comes round towards the third hour, *night and day*, for the period named, the child is to be lifted to its mother's breast. This is the first rule of infant nursing. It must not be broken for any reason. It is a great temptation, if the child is sound asleep, to let the hour slip past; and many are proud to tell how the child slept for five or six hours on end. This is a mistake. The child must be wakened at the hour and sufficiently roused and kept awake till it has taken a proper quantity of milk, when it will, in all probability, drop off at once to sleep again. On the other hand if it has been allowed to sleep for five or six hours, the chances are that wind has collected in its stomach and bowels, and its next drink will be followed by an attack of colic and a screaming fit. The mother or nurse will pay dearly for her five or six hours' rest by half an hour's entertainment of this sort. If, on the other hand, the rule is strictly followed, the child will fall in with the regular ways almost naturally. Within a couple of days the mother will have no need of a clock to regulate her suckling. The child will wake up at the hour with almost perfect regularity, will go to sleep after its drink almost immediately, and in ordinary circumstances will give no trouble whatever. Each breast should be given alternately. Often one nipple is hacked and very painful, and the mother shrinks from giving that breast, and delays. This is a most serious mistake, and the greater evil of a "gathered" breast may be the result. To prevent such results the slightest crack of the nipple should be treated thus: carefully dry the nipple after each suckling and place over it a pad of cotton wool, the centre of which is soaked with glycerine of tannin (obtained from druggists). Before the child is again put to the breast remove the wool and bathe off the glycerine of tannin, which is again applied when the child is removed. If this is not sufficient to heal the hack, then let the mother secure without delay a glass nipple shield with india-rubber tube and teat attached, as shown in the Plate of Nursing Appliances. Usually the shields are sold with the teat on the end of the glass, no tube intervening. It is better to have the tube, because by it the mother may apply the shield and herself suck till the milk fills the tube, then putting the teat into the child's mouth. Thus the child is not worried by sucking in vain for some time. The shield should be worn at each suckling, and the wool with glycerine of tannin applied in the interval till the nipple is quite healed.

Usually mothers err by giving the child drink too often. If the child is the least peevish or fretful, the nipple is forced into its mouth to stop its crying, and the child, whether hungry or not, instinctively begins to drink. Should the fretfulness have been caused by the uneasy feelings of an overloaded stomach, this only increases the evil.

The mother must also take care that the child does not drink too much at one time. It usually indicates itself when it has had enough by withdrawing from the breast. It should, therefore, be allowed to drink till it voluntarily leaves off, and should not be urged to resume it again. If, as is frequently done, the nipple be again put into the infant's mouth, the mere contact calls into play the instinctive act of sucking, with the result that more milk than is needed is taken, the stomach is overloaded and may soon indicate this by rejecting some of its load, or, if it remain, the child is uneasy and restless for some time afterwards.

It sometimes happens that a proper flow of milk is not established for several days after the birth of the child. It may be no milk is forthcoming for a day or two. In these circumstances the child should still be put to the breast occasionally to excite the gland, but it must also be regularly fed. For this purpose a mixture of one-third cow's milk and two-thirds warm water, barely sweetened with loaf-sugar, or, better still, sugar of milk, is the best. It should be given, *not by spoon, but through an ordinary feeding-bottle*, to accustom the child to the use of the nipple. As the mother's milk is gradually formed, the supply of this mixture should be diminished, till, with an abundant supply of the former, the latter is entirely withdrawn.

The first breast milk is of a peculiar character. It is thicker and of a yellower colour than ordinary breast milk, and is called **colostrum.** It usually acts upon the child's bowels, and aids the expulsion of the material present when the child is born, which is usually of a dark offensive character. It is beneficial, therefore, to the child to get this first milk, and *it makes it unnecessary for the child to have any other opening medicine.*

A nursing mother will not take long to discover that the qualities of her milk vary with her state of health, and with the character of her diet. If she is honestly doing her duty towards her child, she will soon regulate her own food by the one condition of its agreeing

with her infant. Her food must be abundant, for it must supply the wants of herself and her child. The intervals between each of her meals ought not to be too prolonged. Four hours or thereby is as long an interval as is advisable. If she has fasted long, and, before herself taking food, suckles her infant, the child is apt to be disturbed and uneasy. The food should be plain and nourishing, abundance of milk, bread and milk, porridge and milk, milk puddings, eggs, fish, soups, flesh and fowl, prepared in simple methods. Highly spiced dishes, with pastries and puddings, green vegetables, uncooked fruits, cheese, &c., are very likely to call forth very strong objections from the child. Every mother, however, must determine for herself what she can safely take, so far as her child is concerned, for what one mother dare not take without exciting screaming fits in her child, another mother can take without her infant being the least disturbed. As a rule stimulants are not necessary or desirable. If, however, a mother has reason to believe that her milk is not sufficiently nourishing to the child, its quality may often be improved by her taking about one-third of a pint of good stout to dinner, and perhaps the same quantity towards evening.

The milk is profoundly affected by the mother's state of mind and body. If she has been over-fatigued, if she has been worried or annoyed, her child is likely to suffer, and to add to her troubles. But nothing so quickly and seriously affects the quality of the milk as sudden emotion, passion, or excitement of any kind, a sudden fear, or fright, &c. The bad effects exhibited in the child are sometimes extremely serious and prolonged. Therefore a mother should endeavour to maintain an equable and calm frame of mind. She should avoid all undue excitements, pleasurable or painful. She should always have her due amount of sleep, and a daily moderate amount of exercise. The quality of the milk is affected by another circumstance. As a rule so long as the mother continues nursing her monthly illness does not return, and also as a rule she does not become again pregnant. But the rule has numerous exceptions. It is very seldom that the monthly illness of a nursing mother returns soon after delivery, but not so uncommon for it to return about the sixth or seventh month. During the period of the illness the milk is impaired in quality, and the child is likely to be fretful and its digestion to be disturbed. If this happens while the infant is still quite young it may necessitate the mother giving up nursing, but if the child is already six or seven months old it need not cause any inconvenience. The child is probably already having some artificial feeding, and during the period of the illness the breast may be withheld more than usual. It rarely happens that pregnancy occurs during nursing except towards the end of the nursing period. If it do occur nursing must be given up.

To repeat: *up to the age of four or six months the child is to be fed entirely by its mother's milk; it should be put to the breast at regular intervals of about three hours at first, nothing, neither the child's sleep nor the mother's, being allowed to interfere with this arrangement, which is carried out by night as well as by day; after ten days or a fortnight, the child being healthy and vigorous, the interval may be slightly lengthened through the day, and lengthened to four hours during the night.* After a month or five weeks it will often, by judicious management, be possible for the mother to arrange to have a moderately long night's rest, uninterrupted. If the child is suckled about 10 or 11 at night, it may be allowed to sleep on till 4 or 5 in the morning, without a further supply of food. If the child is ordinarily strong, the mother will be able by the exercise of a little patience and perseverance, to gradually train the child to this habit; and its value for herself is very plain. But she will only succeed by herself being strictly regular in suckling the child at the proper times.

Should there be, as there often is, any sufficient reason for a mother not suckling her child, there are two methods of rearing the infant. The one and by far the more preferable method is to secure the services of a wet-nurse. In many families the expense is a fatal objection to this method, however desirable it may be. The second method is to rear the child with artificial food, to rear it "by hand," or to "bring it up on the bottle," as people say.

The choice of a wet-nurse should be made with care. She should be in evident good health, but should also be carefully examined to be sure that she is free from any communicable disease, like consumption and syphilis. For this purpose her teeth, gums, throat, skin and hair, and glands of the neck should be inspected. It is well also to learn the character of her husband, and his state of health. Her breasts should be firm, and should have the knotty irregular feeling of glandular structure, not fat and flabby. The nipples should be well formed, and free from fissures. In order that her milk should be suitable, as regards age, to the child,

she should have been herself confined about the same time as the mother of the child she is about to nurse, and rather later than earlier. Her milk should be examined. It should be bluish-white, sweetish, and should yield on standing a considerable quantity of cream. *The best test of the excellence of the nurse is the appearance of her own child.* If it present any skin eruption, cracks or fissures of the mouth or nostrils, or blotches about the buttocks, she should be rejected.

The wet-nurse should follow the same rules as to frequency of suckling the child as have been laid down for the nursing mother, and her own habits of life must be carefully regulated. Her food should be plain, nourishing, and at regular intervals. She ought not to need stimulants of any kind, neither porter nor beer. She ought to be cleanly in habit, ought to go early to bed, and rise early. She should have stated daily exercise. *Next to the quality of her milk, the quality of her temper is of the most importance.* A bad temper ought to be a fault not possible of being overlooked. It is a strong objection to continuing a wet-nurse if her monthly illnesses return. It ought to be unnecessary to add that the wet-nurse should be carefully and constantly superintended, no matter how trustworthy she may be.

Artificial Feeding.—If a wet-nurse be for some reason or other not obtainable, then the child must be brought up "by hand." *Milk must be prepared so as to resemble as nearly as possible what the mother's milk would be.* Asses' or goats' milk affords the nearest approach. It requires being diluted with water, but no sweetening. Cow's milk, however, is that most easily obtained and most generally used. When artificial feeding becomes necessary it is of the utmost importance that milk of the same cow be regularly obtained, and to secure this arrangements should be made with dairy people who themselves keep cows. For the newly-born infant one part of cow's milk should be mixed with two parts of boiling water, sugar (preferably sugar of milk, obtained from druggists) being added just slightly to sweeten. The mixture should be given through a feeding-bottle. It should be made freshly every time the feeding-bottle is replenished, none being added to the bottle while some milk is still in it. Before each refilling, the bottle, cork, &c. should be carefully cleaned with boiling water, and a fine brush should be used for cleaning the tubes. In fact, after being used, the bottle and tubes should be scalded with boiling water, and then laid aside in a basin of pure cold water till again required. After the first fortnight equal parts of water and milk should be used, as the strength of the child may indicate, and gradually the amount of water diminished, till about the sixth month pure milk is being given. The milk *should be given at the same degree of warmth as the mother's milk would be.* Tested by a thermometer this would be about 98° Fahr. A suitable heat is obtained by diluting the cow's milk with hot water in the proportions named. It may also be managed by placing the feeding-bottle with the mixture in it in a basin of warm water.

As to the quantity required by the child, it is not well to adhere too sternly to hard-and-fast rules. If the child is well managed it will itself be a thoroughly reliable informant as to the needed quantity. As soon as it has had enough it will show a disinclination for more, and this indication ought to be at once accepted and no further supply urged on it. It should get its drink every three hours during the day, and every four or so during the night, for the first several weeks after birth, just as the sucking child does, and if regular habits like this are encouraged, it will take its due supply, no more and no less, and go to sleep again. As it grows older it will desire more at a time, and the intervals may be lengthened. So that a healthy well-managed child will itself quite plainly tell what quantity of milk it needs. As a rule, however, an infant takes from the breast about six table-spoonfuls of milk at each suckling during the first and second months of life. Week by week it takes more and more till, at the age of ten months, it will draw three quarters of a pint and upwards. By the end of the first month an infant fed by hand should be taking upwards of a pint (a pint is equal to 20 ounces—or 4 gills), say 5 gills in 24 hours. At the end of two months it should have nearly a pint and a half, between 5 and 6 gills. At the end of three months it should have between $1\frac{1}{2}$ and 2 pints, between 6 and 8 gills, and so on.

It often happens that cow's milk does not agree well with the infant. It is certain that a child "brought up on the bottle" does not, as a rule, thrive so well as one brought up "at the breast." The child often vomits the milk soon after it has been swallowed, and is affected with colic and looseness of bowels. The milk, as vomited, is usually in large curdled masses. Now the curdling of the milk in the stomach is the first stage in the process of digestion, is a natural process, therefore, and

does not indicate anything wrong, as many mothers and nurses suppose. But cow's milk curdles in larger and more solid masses than human milk in the process of digestion. Human milk forms finer and more flake-like curd. The large solid curd of cow's milk is, therefore, more difficult to digest, and more liable to irritate an infant's stomach than the soft fine curd of human milk. If there is any difficulty in getting the cow's milk to agree with the child, it is well, first of all, to try the effect of boiling the milk before using it. The effect of boiling seems to be to cause the milk when it reaches the stomach to curdle more slowly and in smaller masses. Before trying any other course, however, the mother or nurse ought to assure herself that there is not some simple and obvious reason for the milk disagreeing with the child. She ought to see that the child is not being fed too often, that it is not getting too much at one time, and so on. Many get into the extremely bad trick of quieting a child, on the least suggestion of its crying, by thrusting the teat of the feeding-bottle into its mouth. They allow the bottle to lie by the child's side in the crib, and permit it to suck, at odd moments, all day long, letting it even drop off to sleep with the teat in its mouth. This is purchasing domestic peace at the price of the child's health. For there is no surer way, in the long run, of completely disturbing the child's digestion, and of setting up indigestion, colic, looseness of bowels, sickness and vomiting, than this. Therefore, before mother or nurse concludes that the milk is not agreeing with the child, let her see that no such bad practices as these enter into the question. If the milk is still vomited, let the child be fed with small quantities frequently repeated. For a day or two let it have two tea-spoonfuls of the milk every 20 minutes or so, and nothing else. Find, in short, the smallest quantity that the child's stomach can tolerate at one time. The smaller the quantity, the more often must it be given. The chances are that speedily all vomiting will cease. After it has stopped for a day or so, gradually increase the quantity given and lengthen the intervals in proportion. The probabilities are that, if this method is carefully pursued, in a few days the child will be taking the ordinary quantities of milk at the proper intervals without any bad symptom. If, however, it is impossible by such means to get the cow's milk to agree with the child, a change must be made. If goat's or ass's milk can be obtained, let it be used, diluted, but not sweetened. Failing this, let condensed milk be employed. Most of the condensed milks contain a large quantity of sugar to aid in their preservation. It is best to get unsweetened condensed milk. It does not, however, keep long, and must be rapidly used. It must not be given too strong. For an infant at birth one tea-spoonful to one tea-spoonful and a half to the ordinary teacupful of warm water ought to be sufficient; and the strength should be gradually increased, as is done with ordinary cow's milk, till at six months of age the child gets a mixture made of 1 part of the condensed milk to every 8 or 10 of water. The unsweetened kind requires, of course, slight sweetening with fine loaf-sugar.

A great many attempts have been made to produce a food for infants resembling human milk, Liebig's food for infants, Nestle's food, &c. &c. As a rule, however, they are all deficient in nitrogenous elements; as a result, although they agree with children, the children are soft, flabby, pale, and deficient in vigour. They have soft yielding bones, are very open to disease, and have no great power of recovery.

In no sort of food is this defect more marked than in such as arrowroot and corn-flour, and to a less but still a marked extent, in sago, tapioca, rice, barley. Yet it is a popular delusion that arrowroot and corn-flour are good for children, and very nourishing. *They are not so.* They consist almost entirely of starch, which the digestive apparatus of an infant is not yet prepared to digest. They are bland in character, however, and are not irritating, but are only nourishing in proportion to the quantity of milk with which they are prepared. So far as the arrowroot or corn-flour themselves are concerned, a child fed mainly on them would waste, would be literally starved.

Oatmeal is nourishing, and in the form of oat-flour, of which good kinds are now to be had, is very suitable even for infants. It should be made as nearly entirely with milk as suits the child's stomach. Entire wheat-flour is now made of a very fine kind for infants and invalids, and is one of the best kinds of such food-stuffs. Biscuit-powder is also manufactured for infants' use by well-known and reliable firms. A useful biscuit-powder is easily obtained by rolling a tea-biscuit of good quality into powder by means of a rolling pin. One or two tea-spoonfuls mixed with equal parts of milk and water and a little sugar and brought to the boiling point offers a very good food for infants. It may be thinned with milk and given from a feeding-bottle.

For purposes of night feeding food warmers

are employed. A useful kind is figured in the Plate of Nursery Appliances. It is usual to keep the food in the dish and the light burning beneath it, so that the food is kept warm all through the night. Kept warm for hours at a time the milk is apt to sour. It is better, therefore, to light the wick and allow the food to warm just before it is about to be used, the food being kept cold till then. For a similar reason it is a mistake to fill a feeding-bottle with milk and keep it warm in bed till required. Changes are thus apt to be produced in it injurious to health.

It is necessary again to repeat that milk is the proper diet, and milk only, for a child up to four and even six months of age, and that, as a rule, if the mother or nurse takes sufficient care in regulating the times of feeding and the quantities, difficulties in the way of digestion will be overcome. It is also necessary to say again that the utmost care must be exercised in keeping the feeding-bottle, tubes, and teat scrupulously clean. A speck of old milk, left in either, will speedily set up fermentation in the new supply, and derangement of the child's stomach, looseness of bowels, &c., are too likely speedily to arise.

Bathing and Clothing.—Nothing conduces so much to the comfort and health of a child as regular bathing from the first day of its life. The infant should have its first bath immediately after its birth. The bath should be large enough to permit the child to be covered with water up to the neck. The water should be at the same degree of warmth as the child's body; lukewarm is the best description of it. If regulated by a thermometer, it should be about 98° Fahr. The child's head and face should be first washed with the clean bath water, and then thoroughly dried with a soft towel, the child meantime lying on the nurse's lap on a warmed flannel cloth. The child should then be placed bodily in the bath, supported by the nurse's hand and arm, and gently sponged all over. A small quantity of fine toilet soap should be used. Special care should be taken to cleanse thoroughly the fold of skin at the neck, armpits, and groins. After the washing the child should be quickly but carefully dried, and then those parts of the skin which rub against one another, the folds of the groin, armpit, neck, &c. should be lightly dusted with fine violet powder. A great many nurses are careless in the drying, thinking the dusting powder is put on for this purpose. This is a great mistake. If the powder is put on the skin still damp it forms a cake; and nothing is more likely to irritate and inflame the child's tender skin and lead to the formation of sores. The skin must first be quite dry, and then the powder applied helps to diminish the friction between the opposing surfaces of the skin. For a similar reason the powder must not be too freely applied, a very fine film of it being all that is necessary.

The bathing process should be performed before a fire, draughts being kept off by a screen.

The newly-born infant often has its skin coated in various places, and specially the head and folds near the joints, with a thick whitish scum difficult to wash off. This is most easily removed with oil, olive-oil, sweet-oil, or butter, if no oil is at hand. The nurse takes a little oil in the palm of her hand, and rubs it over the part gently but firmly till a sort of lather has been produced. A sponge with clean water and a little soap will then readily cleanse the skin. The eyes of a newly-born infant should be specially looked at, every particle of matter being removed with a clean sponge and pure warm water. Any appearance of matter coming from them within the first few days after birth should cause special attention to be directed to them. (See INFLAMMATION OF THE EYES OF NEWLY-BORN CHILDREN, p. 458.)

Children should be bathed twice daily, in the morning immediately after rising and in the evening before going to bed, and *always at the same hour*. In fact if the same regularity advised in regard to the giving of food be practised in regard to the bathing, it will add much to the comfort and general health of the child, and will do a great deal towards making the child bright and active throughout the day, and towards securing for it sound refreshing sleep throughout the night.

The evening bath should be the principal one of the day, the child's body being then well washed all over, soap being used; the morning bath need not be much more than a dip in plain water, and sluicing with the sponge. As the child grows, the warmth of the morning bath may be gradually reduced a little, and at six months the child, if it is healthy and vigorous, may be freely sponged in the morning with nearly cold water if the weather is warm. The cool water should only be applied with the sponge, the water in the bath in which the child is set down should be warmer. After the cold sponging the child's body should be well rubbed with a fine towel; and if there is any

sign of chilliness or blueness of the skin, the cold sponging should be stopped and not used again till the child is older. No mistaken notion of "hardening the child" should lead to persistence in the use of water manifestly colder than is consistent with the child's comfort.

Food should be given *after not before* the bath.

Many mothers and nurses abstain from giving the usual bath for very trifling reasons. If the bath is properly given, and if proper care is taken to guard against chills, which ought always to be done, there are very few circumstances, indeed, in which it can do any harm. On the other hand, at the outset of many childish complaints, the warm bath is of the greatest possible benefit. It not only cleanses the skin, and stimulates the activity of the sweat-glands in removing waste substances from the blood, but it causes relaxation of the blood-vessels of the whole surface of the body, and consequently brings the blood to the skin in greatly increased quantity to the relief of deeper parts.

Clothing has for its object the maintenance of a certain regular degree of warmth, and its nature and amount ought, therefore, to be determined by the external temperature. It should vary, that is to say, with the climate and the season of the year. In section XI. it has been explained that the skin plays a very important part in maintaining a regular bodily temperature. When the heat of the atmosphere is higher than the proper bodily heat, it has been explained that the body heat is kept at its due level by the blood flowing in larger quantity to the skin, and by heat lost in evaporating increased perspiration; and when the heat of the atmosphere is less than that of the body, a lowering of the bodily temperature is to some extent prevented by the contraction of the blood-vessels of the skin, diminished sweat, and consequently a diminution in the loss by evaporation. In climates where the heat of the atmosphere is very different from that of the human body, and where the variations are great, men must come to the aid of the ordinary healthy processes of the body. In warm climates clothing is used which reflects, throws off, as much as possible, the heat of the sun, and is, at the same time, fitted to permit of free perspiration, while in cold climates clothing is used to retain the heat of the body and prevent it passing off. While infants' dress ought to fulfil the same purposes, it must be remembered that the heat-regulating apparatus, so to speak, of the child's body is not yet in full working order, and the child is consequently much more sensitive to changes in the surrounding atmosphere, and much more strongly affected by them. A slight change in the heat of the atmosphere, to which a man's body so readily adapts itself that he is barely conscious of it, may strongly affect a child; and this should always be remembered by mothers and nurses.

The second special point to notice regarding infants' dress is that it should be so put on as to interfere as little as possible with all natural movements. This requirement is not satisfied when free movement is permitted to arms and legs; care must be taken that the movements of breathing are not hindered. Most of mothers and nurses make this mistake at the very outset. They apply the binder so tightly round the child's belly and chest, in the delusion that its back is thus supported, that its breathing is greatly impeded; and often permanent injury is inflicted on the lungs. Acting under the same mistaken idea they encase the child's body in stays (so-called), and with a multiplicity of other wrappings reduce the infant to a condition of miserable bondage. A third point worth remarking upon is that an infant's skin is not only very sensitive to changes of temperature, but is also very readily irritated in various ways. The mere mechanical irritation produced by the rubbing of rough cloth, will often cause the appearance of a rash on the skin, and will at least be a source of great discomfort to the child. This is a cause of annoyance not to be overlooked in dealing with a fretful child. For this reason the child should have next its skin some very fine soft material. For the same reason wet napkins should be quickly removed, as well as any other article of dress that has become damp. The skin is very speedily inflamed, and cracks and fissures are very readily caused, by contact with wet clothing, especially when wet with irritating material such as that of the discharges. Before replacing dry napkins the skin should be carefully dried and dusted, if previously sponged so much the better. It may be added that the napkins or diapers should not be washed in water containing soda. Pins, even safety-pins, should, as far as possible, be avoided in an infant's dress. Extreme restlessness, crying, and sometimes even convulsions have been caused by carelessly applied pins, whose points had worked themselves into the child's skin.

What manner of child's clothing, then, best

fulfils the conditions that have been set forth? Flannel ought, undoubtedly, to form the chief part of an infant's dress, a long-sleeved flannel gown from the neck downwards being the principal garment. As, however, the child's skin is apt to be irritated by rubbing against the flannel, a shirt of fine lawn is usually put on next the skin. It is customary also for a roll of flannel—a binder—to be wound round the belly. During the early weeks of the child's life this is valuable, by giving protection and support to the navel. *But it is almost constantly too tightly drawn*, and seriously interferes with the action of the chest and belly, greatly impeding breathing. It should always be so slack that the hand can be readily passed between it and the skin. The use of the binder should not be continued longer than six or eight weeks. After that time it should be daily made narrower and shorter till in a few days it is entirely given up. The flannel dress should be fastened by means of buttons or tapes, even safety-pins being not devoid of danger, and it should extend for 10 inches or so beyond the feet to keep the legs warm. It should never be so tight-fitting at any part as to limit freedom of movement. A light woollen shawl, to be thrown over the child when it is being carried from one part of the house to the other, completes all its necessary clothing. The head needs no special covering indoors, either by day or by night. When the child is taken out, it requires a covering for the head, a soft, light woollen hood being preferred, and it also needs an extra wrap, a woollen shawl being the best. If a cloak is used, the mistake should not be made of fastening it on by tying round the neck only, half strangling the child, as it too often does. The thickness and closeness of the material forming the added garment should depend upon the weather and season of the year. About the third month of life, when the child begins to exercise its limbs more freely, its clothes are usually shortened. Stockings and soft pliable shoes become necessary. The clothing at this period commonly consists of a linen, cotton, or flannel shirt next the skin, of a pair of stiff-starched cotton stays, of a flannel petticoat made with a body, an outer cotton one, and of a dress with short sleeves. There are some objections to be taken to this arrangement. The shirt should always be of flannel, unless that has already proved too irritating. The stays are worse than useless, they are positively injurious, a hindrance alike to free movement and free growth. There is no justification of any kind for retaining them. Instead of each petticoat having a body of its own, or being simply buttoned at the waist, a light flannel body should be made separately. Round the waist it should be provided with buttons to fit corresponding button-holes in the petticoats. With this arrangement, if one petticoat be wet it can be removed at once without undressing the child. From the waist-band of this body suspenders for stockings can be attached. The dress should always have long sleeves, and should not be low-necked.

For night a woollen night-dress should be provided, but no night-cap or other covering for the head.

Exercise, Air, and Sleep.—Even the very young infant derives great benefit from such exercise as is directly possible to it, as it lies free and unrestrained on its mother's or nurse's lap. For this reason the washing and dressing of a child should be leisurely rather than hurriedly performed, provided care be taken against the risk of cold. Even the youngest infant should be accustomed to the open air, carried in its nurse's arms. The daily airing should be a regular ceremony, on dull as well as on bright days. The child should have extra clothing according to the season and the state of the atmosphere on the particular day; and the face should be protected by a light veil. With such precautions the child will not be affected by moderate changes of weather; and it will seldom be necessary to prohibit its going out. At first, of course, the infant is to be taken into the open air for only a few minutes at a time, fifteen to twenty, and the time is to be gradually extended as seems desirable, and according to the state of the weather. Carrying in the nurse's arms is better than wheeling in a perambulator. The motion of the perambulator is not so agreeable, and the child is apt to become stiff and chilled in a constrained position.

As regards rest, the infant passes most of its time asleep, and it is, therefore, important to make no mistake regarding its bed and bed coverings. From its birth the child should sleep in its own bed and *not with its parents or nurse.* A wicker basket, lined inside, provided with a firm mattress, covered by a small blanket, a small, not too soft, pillow, and a miniature pair of blankets and down quilt, form a very comfortable sleeping-place. The bassinet should be raised off the floor. Children are commonly kept too warm in such little cots, coverings being heaped upon them, curtains being drawn round

their heads, so that they are often completely covered up, no regard being paid to the means by which fresh air is to reach the child. As a result when the child is lifted out of the bed, it is streaming with moisture, its head being bathed in perspiration. Care is certainly to be exercised to prevent draughts sweeping below the crib or round its head, but the basket should be freely open in front towards the child's face, which should never be covered up. Perspiration bursts out over the child's head if the pillow is so soft that the head sinks down into it. Down pillows and mattresses are, therefore, bad. The pillows and mattresses should, on the other hand, be firm enough to offer sufficient though gentle support to the child.

The excessive warmth to which the child is usually subject in its cot is not so injurious even as the bad air which it is so frequently caused to breathe. Not only, therefore, must curtains not be drawn round its head, but care should be taken to ensure that the room in which it sleeps is duly and properly ventilated, but so as to avoid draughts. The opportunity should also be taken whenever the child is out of the apartment to air it properly. The room should be directed to the south, if possible, and air and sunlight should have free access to it, for air and light are as necessary for healthy growth as food. It is always advisable to regulate the warmth of the room by means of a thermometer, instead of leaving it to the feeling of parent or nurse, and the heat should be kept as regular as possible, the mercury standing at 65° Fahr.

Use of Medicines.—As a general rule if infants are properly managed they require very little medicine of any kind. But with many people it is a matter of custom to give a dose of castor-oil, or magnesia, at regular intervals, every two or three days, or once or twice a week. According to their view, the child could not possibly continue well without such meddlesome interference. From the day of its birth onwards for the slightest reason, and frequently without reason, the child is dosed with opening medicine. The result is that irregularity of the bowels is set up, and a great amount of harm done which it is very difficult to rectify. Now a healthy infant needs no medicine whatever as a matter of course, and the giving to it of medicine of any kind ought to be an unusual rather than a customary practice.

The first milk drawn from the breast of a nursing mother is of a peculiar character and is called **colostrum**. It has an opening effect on the child's bowels, and the first material passed from the child is usually of a dark brownish colour. There is, therefore, no necessity for the newly-born child, that is being nursed by its mother, getting opening medicine, for that has already been provided for *by nature*. This is one of the reasons why the child should be put to its mother's breast shortly after birth. After this the child's bowels ought to move naturally twice or three times in twenty-four hours, and the stools should be of the thickness of thin mustard, of a light yellow colour, free from lumps or curdy-looking masses, and passed without pain or disturbance of any kind. Frequently the motions are greenish, very offensive to the smell, and lumpy with white portions of curd, and to remedy this it is usual for the nurse at once to resort to the use of castor-oil, magnesia, or other medicine of a like effect. Now the cause of this condition is commonly bad methods of management. The child is geting too many drinks, or too much at a time. The curd is simply portions of undigested milk passing unchanged through the bowels, because the bowels are unable to digest the large quantity passed into them at one time. The remedy, at least in the first instance, is to correct the bad nursing, to give the child the breast less frequently, or to give it less at a time, or to do both these things. If the mother or nurse will really put it to herself that she is to blame for the state of the child's digestion, and will correct the mistakes she is making in suckling, the natural condition may be restored without the use of medicine. One of the results of this improper feeding is that the infant is troubled with wind and is much pained. For that reason, also, the mother hastes to give medicine instead of setting right her improper ways of nursing. If, however, the bowels continue for two or three days in this state, and the child is very fretful and uneasy, it may be desirable to give one dose of medicine, effectually to clear out the bowels, and permit a fresh start. For this purpose one or two tea-spoonfuls of castor-oil are the best means. But the mother must not forget that the relief will only be temporary, unless she takes care to manage the child better for the future. The same general principles should be the guide in rearing a child that is being brought up on artificial food. Here, it may be necessary to give medicine to secure a motion within the first two days after the child's birth, because it is not getting the benefit of the first milk of its mother. Castor-oil is here again to be given, and thereafter regularity of the

bowels is to be secured by attention to the feeding rather than by any giving of drugs. There are numerous cases where from its birth the child exhibits a tendency to costiveness, the proper methods of treating these cases are mentioned further on (p. 462). *The rule to be remembered, however, is that regularity of movement of the child's bowels is to be secured by proper feeding and not by medicines.*

Opening medicines are also the common resort when a child seems troubled with any irritability of the stomach. If it vomits its milk, and specially, of course, if this happens frequently, it must be dosed with some drug or another. Here, again, in all probability the fault is the mother's. It is commonly an overloaded stomach that is indicated; the child is allowed to take, or is forced to take, too much milk. Perhaps the mother's breasts are very full, and the milk flows so freely that the child can scarcely drink fast enough, and gulps it down, or perhaps the mother puts the nipple again and again into the infant's mouth, and encourages it to take more, when by withdrawing its head, it has already indicated its satisfaction. In such cases the vomiting is simply nature's method of disposing of the excess. When mothers see this, their business is to try to make the child drink more slowly, to take away the breast when they think the child has had enough, and never to urge it to take an extra supply. As soon as this has been done, probably the vomiting will cease. If, however, medicine does seem needful, then it ought to be a simple dose of one or two tea-spoonfuls of castor-oil, or two or three tea-spoonfuls of fluid magnesia repeated occasionally for a day or two.

Many people find it very difficult to give medicine to infants. The child can easily be held on the left arm, propped up with its head resting on the shoulder and held so by the arm gently pressing the head against the person's chest, the hand of the same arm being brought round in front to hold down the infant's hands. The medicine is taken in a small spoon in the right hand, and gently, but firmly, introduced into the mouth far enough to place the medicine well back on the tongue. If this is properly done the child cannot help swallowing it. *Only a small quantity should be* taken on the spoon at a time, about a quarter of the spoonful, and when that has been disposed of a little more is given, till the necessary quantity has been swallowed.

A second thing which some nurses are too ready to do is giving the lately-born infant a little gin and water or a little spirits of nitre and water, because the child has not made water, or what they think not enough. This must never be allowed. A small quantity of water may be made but be unnoticed, because of being soaked up by the cloths. Even though it is quite certain that no water has been made, drugs must not be given. A pad of flannel wrung out of moderately warm water and placed over the lower part of the belly and between the legs will usually be sufficient to encourage the flow. This application may be repeated for several times. Nothing else should be done without medical advice.

Stimulants of any kind should never be given to children by parents or nurses. A doctor may find it advisable to administer them in certain cases, but on no account should others employ them without medical orders.

Some form of stimulant is often given to dispel wind, but there are some harmless drugs, such as dill water or essence of anise, which are equally satisfactory in their action. The method of giving them is mentioned on p. 461. But again it cannot be too strongly insisted on that flatulence and similar disturbance of the bowels are due most frequently to bad management in suckling or feeding, and that that evil should be rectified. The practice of giving to children, and specially to infants, what are insinuatingly called *soothing medicines* cannot be too strongly condemned. The effective ingredient in the most of these compounds is *opium* in some one of its forms. Laudanum itself, the tincture of opium, is frequently given on sugar by unscrupulous nurses or careless mothers, to quiet a fretful child, whose pain, restlessness, and sleeplessness are due to wretched mismanagement or gross inattention. Even mothers who would not dream of giving laudanum or opium to any of their children are glad to make use of preparations in which the opiate is masked by some special name, such as Mrs. Winslow's Soothing Syrup, Godfrey's Cordial, Dalby's Carminative, syrup of poppies, &c. &c. In each of these it is the contained opium that produces the so-called soothing effect, and each is capable, if used in sufficient quantity, of inducing a "quietness" that will not again be broken. *One drop* of laudanum has killed a child, and numerous cases of infants' deaths have been reported in medical journals from the use of Mrs. Winslow's remedy, and from such preparations. Medical men themselves are extremely chary of administering opiates in any

form to young children, even in cases of serious disease where their use seems demanded, and when they do feel compelled to use them they are extremely careful in prescribing the dose and in watching its effects. *Children are extremely susceptible to the action of opium.* This must never be forgotten, for of some other drugs, of which *belladonna* is a good example, they can "stand" a larger quantity than most grown-up persons. It ought then to be a rule, never departed from, that neither opium nor any of its preparations, nor any compound in which it exists, is ever to be administered by mother or nurse to a child. Mothers who intrust their children largely to the care of nurses, cannot be too careful in seeing that the nurse does not *secretly* employ such remedies to give herself greater ease and convenience by drugging her charge to sleep.

To sum up, the only medicines parents or nurses need have at hand are castor-oil, magnesia, and dill water. If they are kept at hand in case of being required, they should, nevertheless, be sparingly used. The child, it may again be repeated, ought not, in ordinary cases, to be *restored* to a proper condition by the use of medicines, but ought to be *kept* in a healthy state by proper feeding and general careful and watchful management.

Premature children.—It is only necessary to say a word or two about the extra care required for children born before full time. The more near the infants are to the full period of nine months, the greater is the likelihood of careful nursing enabling them to survive. It is a vulgar notion that a seven months' child has a better chance of continued existence than an eight months' child. This is not so. A child that has passed eight months within the womb is in every way more developed than one that has passed only seven months, and its chance of survival is consequently proportionately increased. The chance of a child born before the seventh month is comparatively small. Nevertheless there are numerous cases on record of infants, born between the sixth and seventh month of intra-uterine life, surviving and thriving satisfactorily. The two difficulties are those of feeding and keeping warm. The child is often too feeble to suck, and artificial feeding is necessary, because the mother has no milk. If the child can be made to suck, milk prepared as directed on p. 438 should be given from a feeding-bottle. To aid the child a small teat should be used, and the nurse should see that the milk can be drawn easily. The child should take from four to six table-spoonfuls at one time, and should get a drink at intervals of an hour and a half to two hours, and more frequently if a less quantity is taken at each time. If the child cannot suck, the milk must be given with the spoon, and it is better to give small quantities at frequent intervals, two to three table-spoonfuls every hour, than to attempt to give larger quantities less frequently. With premature children the difficulty of maintaining the bodily heat is great. To secure this it is sometimes necessary to surround the child, face excepted, with cotton wool. Care must also be taken with the skin, which is very tender, easily ruffled and inflamed.

Vaccination.—This is compulsory by law in Great Britain within the first six months of infant life. The purpose and value of vaccination have been fully discussed on pp. 406–409. It may be advisable to re-state here that a child should be vaccinated between the second and fourth month after birth, before teething begins, but that if small-pox be prevalent at the time, and if there be any danger of infection, it cannot be vaccinated too soon. *There is no risk at all to be compared to that of catching small-pox in vaccinating even the day after birth.* It may also be again stated that if the vaccine matter is taken from a healthy child on the eighth day after its inoculation, and if proper precautions be observed in taking the lymph to ensure that only lymph and no blood be taken, there can be no risks whatever of transferring any disease. Further, the extremely painful, red, and swollen arms that one occasionally sees are in most cases due to the carelessness of the mother or nurse in not properly guarding the arms from injury by rubbing or in other ways, and specially to badly-adapted clothes which compress the parts at the armpit and lead to inflammatory swelling of the whole arm. The full measure of safety is secured when four good vaccination marks are produced. The mother, therefore, should allow the child to be vaccinated on four "places" if she wishes the utmost benefit of the operation. Many doctors vaccinate only on two "places," and if the district where the children live and are likely to remain is commonly free from the disease, so that the risk of infection is slight, two marks may be satisfactory enough. Vaccination on only one place, however, is too little to be satisfied with. If, however, there is any risk of infection in the neighbourhood where the child lives, or if there is any likelihood of

the persons removing to any district where there is risk, vaccination should be performed on four "places" to secure the greatest amount of protection. If children are well managed they should give comparatively little trouble during the period when the vaccine is operating on the body. Careful dieting, the usual attention to bathing and cleanliness, attention to the bowels, and care to prevent injury and irritation to the arm, ought to ensure little disturbance. If the child suffers at all it will be between the seventh and tenth days, when it may be hot and restless, and the bowels slightly disordered. A tea-spoonful of castor-oil, or three or four tea-spoonfuls of fluid magnesia is all the necessary treatment. The heat of the vaccinated part may be soothed by placing lightly over it, if it seems needed, a piece of lint soaked in cold water, and keeping it soaked. If the lint is allowed to dry, it will adhere to the part, and attempts to detach it will cause still more pain than before.

Some children, comparatively few, however, fail to take the vaccination. By the Vaccination Acts the operation must have been performed three times and failed each time, before the child is declared insusceptible. If this has been done the doctor will give a certificate to that effect. But it would be well if the operation had failed twice with lymph obtained in the ordinary way, that it should be tried the third time with calf lymph.[1]

Should a child not be in good health, a medical man may, if he deems it advisable, postpone the operation to a period beyond the legal six months by signing a certificate to that effect.

Revaccination is considered on p. 410.

THE MANAGEMENT OF CHILDREN BETWEEN THE SIXTH MONTH AND SECOND YEAR OF AGE.

Food.—Up to the sixth month the child has either been nourished entirely by the breast milk, or by milk food given through a bottle, or by the breast milk supplemented by the bottle food. By this time it becomes necessary to make considerable additions to the diet. If the child is being suckled, and the mother has still a good supply of milk, the addition should consist of one meal per day, given about midday. It should be made of milk thickened with some well-boiled fine entire wheat-flour, or oat-flour, or ordinary wheaten bread boiled with milk and sweetened. Biscuit powder may also be used, or a scalded rusk. This should be made of a thickness that will permit of it being drawn through the bottle. A good food is made of the following:—

Malt	½ ounce.
Second Flour	½ ,,
Skimmed Milk	6 ounces.
Water	1 ounce.
Bicarbonate of Potash	7¼ grains.

Grind the malt in a mortar or coffee-mill; mix all the ingredients together; put in a pan thoroughly clean, and place by the side of the fire so that it becomes just lukewarm for 15 minutes; thereafter boil for 6 or 8 minutes; strain through a sieve or muslin, and give through a feeding-bottle. Some mothers, however, who regularly suckle their children, and have a strong objection to feeding-bottles, prefer to give such an addition to the diet in the form of spoon food, and there is no objection to this: the food only requires to be made thicker. Beginning with one meal a day of this kind, the child may soon get a second meal of a similar kind, the frequency of giving the breast being correspondingly diminished. If the mother's milk is rapidly diminishing, it is common to feed the child through the day, and give the breast only at night. It is better to give the breast once through the day and once through the night, and to give the other food at regular intervals between these times, contriving to give the last spoon or bottle food just before it is customary for the mother to retire so that she may not be disturbed till towards morning. It is too long an interval for the milk to stay undrawn in the breast between one night and the next, and therefore advisable for the child to be put to the breast once during the day. If the child is being brought up by hand, then the addition to the diet can be made at one of the ordinary times of feeding. In every case, however, the same regularity in respect of time of feeding, and the same care against overfeeding, must be exercised as have been already recommended in the management of the newly-born child. If one form of food disagrees with the child let another be tried. Derangement of the stomach and bowels is to be met by a change of diet rather than by the giving of medicines.

[1] There are several associations now in London for the supply of pure vaccine lymph, calf lymph as well as human lymph. The writer has had every reason to be satisfied with calf lymp obtained from the Association for the Supply of Pure Vaccine Lymph, 12 Pall Mall East, London, of which Mr. Ed. Darke is secretary. Half-tubes, sufficient for one child, are obtained through the post for 1*s.* 1*d.*

By the time the child is eight months old a further addition to the diet should be made by giving once a day a small quantity—a small teacupful at most—of beef-tea or weak chicken or mutton broth or soup from which all vegetables have been removed by straining through muslin and from which fat has been skimmed. The beef-tea is best made by scraping the meat with a knife. Place the scrapings in a jelly-can with two breakfast-cupfuls of *cold* water to each quarter of a pound of beef; set the jelly-can in a pot of hot water, covered with a lid, and allow the water in the pot to simmer for two hours or so. Salt the beef-tea to taste. It should contain all the valuable parts of the beef in fine flakes and should need no straining. If this tends to make the child's bowels too loose, that may be remedied by slightly thickening the tea with rice or corn-flour and boiling it for some minutes.

Weaning should be effected when the child is ten or twelve months old, the exact time being dependent upon the health of mother and child. It will be begun earlier if the mother is suffering from nursing, and delayed till later if the child is weakly and the mother able to bear prolonged nursing and having good milk. The period named is generally chosen because the child usually has about that time an interval of rest between cutting the front teeth and the first of those at the back. It is often a process involving some trouble to the mother and discomfort to the child, but, if the above directions as to feeding have been observed, the child will really have been in preparation for it since the sixth month, and much of the difficulty will be overcome. Weaning should not be allowed to take place if the child is suffering from the irritation of late teething, from any cold, or feverish attack, or trifling illness, but the mother should wait till that has passed off. The process should be performed gradually; as the breast-milk is withdrawn its place should be supplied by other appropriate nourishment. The child's food at this time should consist largely of milk and of the preparations of milk already mentioned, including well-boiled milk porridge, the diet being properly varied from day to day, though given at the same regular intervals, the cup of beef-tea or weak mutton broth being given once a day. At this time, too, a lightly-boiled egg beat up and properly seasoned, given with bread and milk, will be as a rule much relished. The mid-day meal may be thus varied, the egg being given instead of the beef-tea or broth. As the child grows older and more vigorous the quantity of animal food in the diet is to be carefully increased. At about fifteen months of age it may occasionally get a small quantity of well-boiled mealy potato, thoroughly bruised down in its beef-tea or in gravy, and the mid-day meal may also be added to by some light milk-pudding. Before this age no solid animal food whatever should be given. It will be receiving sufficient animal food in a semi-fluid form in the beef-tea, broth, beat-up egg, and so on. But between the fifteenth and eighteenth months the child may be tried with a little meat, if it be scraped down into a fine pulp and given with gravy and a little well-mashed potato. A small piece of chicken may be given in the same way. White fish will also be found usually to agree well with the child's digestion. At about two years of age the child should be getting four regular meals a day:—breakfast of well-boiled porridge and milk, bread and milk, or egg with bread (lightly buttered) and milk; a mid-day meal of beef-tea, broth, or soup, with a little well-mashed potato, and afterwards some light milk or egg pudding, or some well-chopped-up meat —beef or mutton—or fish or chicken, with potato and pudding afterwards; a tea of bread, butter, and milk, and the bread may be spread with jelly, honey, or syrup instead of with butter; and for supper bread and milk. Some regard should be paid in dieting to the relation of the meals to one another. If the breakfast consists chiefly of porridge and milk, or bread and milk, the dinner should contain a good proportion of animal food in the shape of egg, fish, or butcher-meat of some kind. For it must not be forgotten that at this age the child cannot obtain sufficient flesh-forming material from oatmeal or bread, and still less from rice, sago, corn-flour, or such substances. It cannot even drink sufficient milk to supply this want. The result will be that, if animal food is not supplied, the child will be soft, with soft bones and flabby muscles, wanting in sustained energy. The necessary animal part of the diet should therefore be made up at breakfast or dinner, and if, owing to the nature of this meal, on some occasion it is in deficient quantity, it may be made up at tea by a part of an egg or a whole egg. Animal food should be given preferably at mid-day. The meat should be boiled or roasted. Salted meats, pork, veal, and lamb are to be avoided. A small quantity of vegetable may also be allowed when the child has reached two years of age, potato as already mentioned being given earlier than that age, if

not new and if mealy and well mashed; but by two years carrot, turnip, and cauliflower, well boiled, may be permitted in small quantity, not cabbage or green vegetables. Soft green peas may be allowed. Some cooked fruits—stewed apple or prunes—will usually be relished given with well-boiled corn-flour or rice, but uncooked fruits are injurious, except the orange when in season, the child being taught to reject the skin and seeds. Pastry and nuts are to be avoided. The diet recommended will strike many people as generous, and liable to lead to overfeeding. It will not do so if the child receives its meals at regular times, and does not get additional food at odd moments. If a child has its regular meals it will take at each what satisfies it and no more, provided an undue variety of dishes be not produced to stimulate its appetite. But if in addition to its own meals it is permitted partly to share its parents', then overfeeding or digestive troubles will likely arise. As great an evil is the giving of sweet biscuits, pieces of bread and jelly, and so forth, between meals. Parents should from the first entirely set their face against "pieces" between meals. They prevent a healthy appetite at the proper meal-time, and derange the digestion besides. As a rule also sweetmeats are given very indiscriminately. An occasional sweetmeat is not hurtful, if only one be given occasionally. Those made entirely of pure sugar, or a gum pastille, or a small piece of chocolate may be given, *but only occasionally.* Any containing almonds, nuts, &c., should be avoided. Similarly, cakes with raisins, currants, &c., should not be given. Plain sponge-cakes or plain biscuits alone are admissible, but ought to be used at meal times as an addition to the meal, and not between meals.

Finally, children should be taught to take their food slowly and to chew it thoroughly.

The only **beverages** for children are milk and water. The practice of giving small quantities of wine, malt liquors, or stimulants of any sort for little ailments is hurtful in the extreme; still more is the habit of giving these things as a matter of course a most pernicious one. Stimulants should be given to children only on the direct order of the medical attendant, and then only in the small doses he orders, which should be carefully measured. As regards tea, many parents like their children beside them at table, for one meal at least, when they reach two or three years of age, and tea is often the meal. The child may have its cup of warm milk and water sweetened, and if it be barely coloured with tea no harm is done, but it ought not to be more than barely coloured. Thin cocoa, made mainly with milk, is, however, quite digestible for children and also nourishing.

Teething. The first set of teeth are called the **milk-teeth**. They have usually all appeared above the gum by the end of the second year of life, or from that to the thirtieth month. The full set consists of twenty teeth, ten in each jaw. The ten are formed of four central **incisors**, or **cutting** teeth, one **canine** or **eye** tooth at each side of these four, and two **molar** or **grinding** teeth at the back on each side. They appear on an average at the following periods:—

Two central cutting teeth, ...	7th month.
Two side, ,, ,, ...	9th ,,
First back tooth, ...	12th ,,
Eye-teeth, ...	18th ,,
Second back teeth, ...	24th ,,

The first teeth of the lower jaw appear earlier than those of the upper jaw. While the above table gives the average dates, the period varies greatly. Thus the central teeth of the lower jaw may appear as early as the third month, and an interval of some months may then elapse before others are cut. There are cases on record of children being born with some teeth already cut. On the other hand, in some cases the teeth are unusually late of appearing, some remarkable cases being on record of children who cut no teeth till some years after birth. As a rule, if the cutting of the teeth is long delayed, it is an indication of some backwardness of development. It may be due to the child not getting food of a proper quality to supply the needed material for tooth formation, and the slowness of the growth of the teeth may coincide with slowness and softness of bone formation. Parents in such cases should consider whether the child is receiving a sufficiently nourishing diet, and especially should be assured that the diet is not too exclusively of a starchy kind, too much corn-flour, rice, arrowroot, or kindred food, and too little milk, and whether some addition of beef-tea, broth, eggs, &c., should not be made to its diet.

The teeth are already in their sockets in the jaw when the child is born. It is their continuing growth that causes them to press upwards on the gum till they cut through it. While the milk-teeth are pushing their way upwards the foundations of the permanent set are already being laid in the jaws, and when, at the age of two years or two and a half years, all the milk-

teeth are visible, considerable advances have been made in the development of the second set. It is the continued upward growth of the teeth of the permanent set which causes them to press on the roots of those of the milk set. This pressure gradually causes wasting of the roots of the milk-teeth, till, at six years of age, when the first of the permanent set appears above the gum (see pp. 136 and 137), little of some of the milk-teeth is left but the crown attached to the gum, and it usually drops out as the permanent one pushes up to take its place. But at this time, six years of age, the child has not only the twenty milk-teeth, but more deeply in the jaw it has also, already well developed, twenty-eight of the thirty-two that form the permanent set. At this time, therefore, the child has no less than forty-eight teeth in its jaws.

The period of teething is the time when the advancing teeth are pushing up vigorously under the gum, and when the gum is rendered sensitive and painful by the pressure. The pressure is also irritating to other parts, and the excitement carried to the salivary glands (p. 137) by nervous communication causes the constant flow of saliva. The period of teething is, consequently, a time when the child is more than usually irritable and excitable, and more than usually liable to disturbance of various kinds. While this is so, it is too common to blame teething for all sorts of ailments that have little connection with it, and consequently to neglect attending to some of them, or seeking advice for them, in the hope that when the teeth are cut the ailment will pass away. It is the writer's constant experience that, if the mother or nurse will give a little more than ordinary care to the tending and management of the child, and will watch the condition of the bowels, giving, when it seems necessary, a small amount of gently opening medicine, castor-oil or magnesia, and plenty of careful exercise and fresh air, the troubles of teething will cease to alarm and annoy. The various ailments apt to arise during teething and the method of dealing with them, are considered further on in this section. During the period the child is much comforted, and the process of cutting aided, by having a clean india-rubber ring to press and chew with its gums. As a rule lancing the gums is to be avoided.

For the preservation of the permanent teeth children should be trained to use a tooth-brush with warm water daily, using also if need be a tooth-powder of a fine kind. In order to get the child trained to this habit, it is well to teach it to use a brush, even for the milk teeth. A child of two years and a half is quite capable of being trained to a cleanly habit of this sort, and looks upon it as an amusement rather than as an irksome task.

Bathing, Clothing, and Exercise.—The directions already given about bathing infants should be carried out with older children. About six months of age, sluicing with water, which is just tepid, with the morning bath may be given. That is to say, the bath-tub may be filled with water of a moderate warmth, but the child is rapidly sponged with water less warm. Thereafter the drying should be thorough and accompanied by gentle but firm rubbing. If the child seems to feel the cold too much, the colder water should be abandoned for a time. When children become old enough to stand in the bath for the morning cleansing, the water in which they stand should be warm, and tepid water used with a sponge. Children who are able to stand and run about should not be allowed to scamper over the nursery while the bath is being prepared. The body becomes chilled in this way and is unable to stand the cold bath well. The child should be rapidly bathed just out of bed while it is still in full warmth, able to bear the cold and to induce reaction afterwards. At the same time, if it has been unduly warm and sweating in bed, time must be given for it to cool down in bed before being taken to the bath. After bathing the children should be quickly dressed before a fire and then allowed to run about. The evening bath should be always warmer than that of the morning, and from it the child should be put straight to bed. If the practice of the morning cool bath is kept up, then as the child grows it will be so accustomed to it that it will be desired and continued.

Clothing.—Regarding clothing it is only necessary to repeat the objections stated on p. 442 to low-necked short-sleeved dresses, and to socks so short that they do not protect the legs. The dress should fit well, though easily, round the neck, and should always have sleeves to cover the arms. Colds and chest complaints are too frequently due to the half-naked way in which mothers like to see their children's shoulders and arms. If socks are worn, gaiters should be added to protect the legs. When stockings are used, they should never be secured by garters at the knee, for these restrict the circulation and are hurtful; suspenders are the proper means of keeping them up. The same is true of gaiters. Shoes should be as soft and

pliable as possible. Specially while in the house should stiff shoes and boots be removed. They prevent free growth of the muscles of the feet and hinder vigorous and elastic movements.

Exercise.—Up to the age of nine months or thereby a child's exercise is obtained mostly in its nurse's arms, or lying kicking in her lap or in its cot. About nine or ten months, however, the child begins to attempt crawling. If the floor be covered by a warm rug or carpet this is well, but care should be taken that draughts do not sweep across the floor. From crawling it will take to getting on its feet by the aid of a chair and so on till it essays to walk. A mother should let her child go through all the stages at its own sweet will. It will gradually learn itself to use its legs, will become slowly accustomed to maintain the erect position, and thus the muscles are gradually trained to their full use. This is better than setting a child up on its legs and trying to force it into erect ways of moving. If a child is more than usually heavy, its own weight may be too great for the still soft and yielding bones to bear, and the child is often disinclined to attempt standing up straight. It prefers crawling, and it is right, and ought to be allowed to choose its own way.

When children are old enough to walk out and themselves take exercise in the open air, it is best, if there is an open space for it, to let them do so by engaging in some simple game, rather than by dawdling along holding on by the skirts of a nurse. It is free active exercise of arms as well as legs, and of chest muscles too, that a child needs.

During some part of the middle portion of the day the child should have a mid-day sleep, even when it has reached the third or fourth year. In summer the warmest part of the day is best for this purpose, and the room should be cool and darkened, the child being lightly covered. The time of exercise would thus be in the morning before the heat becomes great or in the afternoon, but before it becomes too cool in the evening. In winter the time of the daily sleep needs some alteration to permit the child being out while it is warmest and sunniest.

Children's Apartments.—In houses where the accommodation is sufficient it is well to have a day and a night nursery. Both should be of a moderate size, cheerful and airy, fitted with a fire-place, protected by a guard so efficient that the child can neither crawl through between its bars nor over its top. The ventilation should be well attended to, and should be secured either by a valve ventilator near the roof communicating with the chimney, or by one of the *topmost* panes of the window being perforated, the openings being capable of partial closure. Heated air always rises, and thus impure air, warm from the lungs, rises towards the ceiling and should be allowed a way of escape as high as possible. The arrangement should be such as to avoid draughts. One good method is to raise the lower sash of the windows by a 3-inch board fixed to the sill and on which the sash rests. A space is thus left between the lower and upper sash through which fresh air enters, but it is directed upwards. If possible, the room should not be next door to a bath-room or water-closet; and it should not be in a sunk flat. The windows should be guarded by rods. The rooms should be heated by fires, and not by hot-air pipes or gas-stoves; the communication between the grate and the chimney should never be closed. It ensures ventilation of some kind when open. As soon as the children leave the night nursery in the morning, the windows should be thrown open to let the room be well ventilated; and similarly whenever the opportunity exists by the room being empty, the day nursery should be aired. Further, a nursery should be kept scrupulously clean; all discharges should be quickly removed, as well as dirty linen. No cooking should be done in it, and drying of clothes before the fire should be forbidden. In houses where the accommodation is not sufficient to allow of even one room being used as a nursery, the benefit of the children should be considered, and the principles indicated carried out as far as possible in the other apartments.

THE MANAGEMENT OF CHILDREN IN DISEASE.

GENERAL SIGNS OF DISEASE IN CHILDREN.

Much may be learned as to the state of health of a person by examining the face, eyes, mouth, and various parts of the body; but in dealing with children, who cannot express their feelings, this examination becomes of very great importance. It is possible from it not only to tell whether a child is well or ill, but often also, if ill, what is the character of the ailment and situation of the disease. The information is to be obtained from observing (1) the colour of the skin, face, eyes, lips, (2) the expression of the face and eyes, (3) the state of the mouth and teeth, (4) the gesture and attitude, (5) the movements of the chest, (6) the movements of the

belly, (7) the general state and warmth of the body, (8) the cry of the child, (9) the character of the stools, and (10) the nature of the sleep.

What should be looked for in each of these respects will be briefly indicated.

1. **The Colour of the Skin, Face, Eyes, and Lips.**—The transparent rosy tint of the skin of the healthy child may be replaced by a general *yellow* colour, seen not only over the whole skin, but also in the white of the eye, indicating jaundice, *i.e.* some affection of the *liver*. A form of jaundice is not uncommon in newly-born children (see p. 459). The skin may be dusky, the lips being bluish, and the same duskiness showing strongly under the finger and toe nails. This is associated with a peculiar condition of the *heart* (see BLUE DISEASE, p. 458). In affections of the *lungs*, where the breathing is seriously impeded, a similar alteration of colour affects the face and lips. Serious disease of the *stomach or bowels* produces a *dull, sallow, or leaden* hue of the face.

(2) **Expression and Features.**—The most remarkable and sudden alteration of features is seen in diseases of some part of *the bowel*, where the face is pinched and furrowed, and becomes rapidly emaciated, sunken, and lustreless. The rapid movements of the nostrils, accompanying laboured breathing, is a sign of *affection of the lungs*. Hacks and fissures about the corners of the mouth, sunken bridge of the nose, and a general withered and old-mannish look, are frequent in a disease of the blood called syphilis (p. 422). A large head, with prominent overarching forehead, and small development of the face, is the well-known characteristic of a chronic form of *brain disorder*—water-in-the-head—(p. 101). In the early stage of this trouble the child is drowsy, dull, and listless, however lively and active it may naturally have been. The eyes should be observed as to the way in which they close, the complete or incomplete way in which the eyelids meet, the presence of squinting; and the pupil should be watched to note whether it responds to light—becoming small rapidly when light is directed on the eyes, and again expanding when the light is withdrawn. A wide and fixed pupil is almost certainly a sign of serious *nervous disturbance.*

(3) **Mouth and Teeth.**—The points to notice here are the heat and state of moisture of the mouth, the condition of the gums, the number of the teeth cut or near to cutting, the softness or dryness of the tongue, its colour and cleanness. In teething, of course, the mouth is hot and perhaps dripping with saliva, and the gums may be swollen, tender, and florid. A white tongue points to disorder about the *stomach.* A brown dry tongue is the state in fever of the typhoid type. The tongue is also frequently covered with patches of a white vegetable growth (THRUSH, p. 460). The inside of the lips and cheeks are to be inspected for the presence of small ulcers.

(4) **Gesture and Attitude.**—Note here the movements of the hands and arms. Children, like grown-up people, often try to aid obstructed breathing by grasping with the hands and raising the arms to help expansion of the chest. In severe *fevers* the rigid bend of the fingers with the thumb doubled in on the palm is very noticeable. In irritation of the *bowels* the thighs are bent up on the belly while the pain lasts. The involuntary movements and twitches of *St. Vitus' Dance* (p. 125) are well known.

(5) **Movements of the Chest.**—Rapid and jerky movements, with constriction at the sides, and accompanied by heaving of the belly, and depression at the collar-bones, indicate serious *lung* mischief. Breathing that is accompanied by a pleuritic stitch is manifested by the sudden convulsive stop in the middle of the inspiration, the pain being also shown by the movements of the face and the cry. Disease of the *belly* also affects the movements of the chest, for if movement of the belly causes pain it will be kept quiet, and all the breathing will be performed by chest movements, which will be short and quick, incomplete, that is to say, prevented from going so far as to exert downward pressure on the belly.

(6) **Movement of the Belly.**—As indicated above, the movements of the belly may be exaggerated, when the disease is in the chest, to relieve the chest of the work it is unable to perform, or the movements of the belly may be entirely restrained when it is itself the seat of disease. In the latter case it will be tense, the muscles firmly contracted to guard against movement, and the thighs will be bent up on it to relieve it of strain. When the belly is the seat of pain, specially colicky pain due to flatulence, the contracted muscles make the belly feel tight and firm, and the child usually kicks and twists itself about, crying lustily while the pain lasts. But as soon as the spasm of pain has passed the child speedily quiets down, giving vent only to a final sob or two, unless another attack rouses it to the same crying and kicking. On the other hand, if the pain is inflammatory the child lies moving as little as possible, for movement

increases this pain, and there is moaning rather than crying out.

(7) **The General State and Warmth of the Body** may be gathered from noticing the plumpness or wasted appearance, firmness or softness of the child. The way in which the child holds itself together, also, should be observed, whether bright and buoyant, or languid and drooping. The heat of the body is roughly ascertained by laying the hand on the skin or on the head; but the most reliable means is by using the thermometer (p. 10). It will indicate a rise of temperature amounting to fever when feeling with the hand would give no hint of anything wrong. A mother who learned how to use it, and it is very easy learning its use, would find it of inestimable value. It would not only tell her whether her child was really ill, but also within an hour or two of the employment of her simple method of treatment she would be able to tell by means of it whether any good had been done.

(8) The **cry** of the child is often peculiar. The feeble, plaintive cry is itself sufficiently suggestive. An acute cry, very strong and intermittent, is not infrequent in "water in the head" (p. 101), while a hoarse, muffled cry is heard in croup (p. 417). If a child, apparently healthy, takes suddenly to a constant crying, which movement and dandling seem only to aggravate, thorough search should immediately be made to see that it is not due to some wayward pin, or some uncomfortable fastening or knotting of the dress.

(9) The character of the **stools**, &c., give important indications of the state of the health. In the case of the infant they should be two in number daily, lightish yellow in colour, soft, and not offensive in smell. If they are not so frequent as usual, or more frequent, dark or green coloured, too liquid, or curdy and offensive, something is not quite right, which some slight alteration in the diet, in quantity or quality, or both, may set right even without medicine. (Refer to page 446.)

(10) The **sleep** of children is disturbed during illness. A restless disturbed sleep, from which the child often starts up with a cry, should always call attention to the child's state of health. It may be only some error in diet that is the cause. If so, this will be indicated by the state of the stools. Perhaps the child has had no motion the previous day. Let inquiry be made, and opening medicine given if necessary. Disturbance in the bowels due to worms is a frequent cause of this restlessness (p. 463). On the other hand, an undue drowsiness, languor, and listlessness are not to be neglected, specially in children between two and seven years of age. These are among the early signs of brain disease.

GENERAL TREATMENT OF CHILDREN IN DISEASE.

When a child is suspected or seen to be unwell there are certain steps that ought to be taken at once, no matter what may be the nature of the illness, steps which, if taken immediately, will, in many cases, be able to convert into a short and slight illness what, if neglected, might become a long and serious one, and which may even be sufficient to arrest the illness altogether. As soon as the child is supposed to be ill it should be stripped, bathed, and put to bed, if possible in a quiet room, not in a noisy, much-frequented apartment. The bed should be fresh and clean, not closed in, and freed entirely from hangings and curtains. *The room should be well ventilated, but free from draughts.* A fire secures a continuous supply of good air to a considerable extent, besides warming the room, which should be kept as much as possible at a regular temperature—a moderate one (62° Fahrenheit)—which is most easily managed by the aid of a thermometer kept hanging in the room. At once attention is to be directed to (1) the diet of the child and (2) the state of the bowels. (1) The whole trouble may have arisen from overfeeding or improper feeding. The child is, therefore, to be put on milk diet mainly, to which, if its age warrants it, light beef-tea or broth (strained) may be added (see the directions given under MANAGEMENT OF CHILDREN, p. 449). The quantity is to be kept strictly moderate, small quantities given in frequent but regular intervals being better than large quantities at one time. Irregular feeding must be avoided, and no solid animal food whatever given. (2) If the bowels have not been properly moved for some time a moderate dose of castor-oil or of fluid magnesia, or similar mild purgative, may be given. This is, generally speaking, all that should be done on the mother's or nurse's sole responsibility, when the services of a medical man are at all obtainable. When such services can be obtained they should be at once sent for, as very slight symptoms may be the forerunners of very serious disease. The medical man being in attendance his advice, *and none other*, should be strictly, promptly, and conscientiously followed.

But it will often happen that medical aid is not within immediate reach; that, owing to distance or some other case, it may be many hours before the doctor can arrive. Meanwhile the child seems highly fevered, is very restless in its sleep, seems to be wandering, or the mother fears convulsions. What is to be done? This, at any rate, must not be done: the mother or nurse must not seek to quiet the child by "soothing syrups" of any description. Especially in nervous conditions is a great deal of harm possible by their means. There are, however, two things the mother may do without the least fear, two things beside what has been already advised. First an injection into the bowel should be given for the purpose of producing at once a full clearing out of the lower bowel. The fact that castor-oil or some other opening medicine has been already given does not stand in the way of the injection, if it seems needed, for the injection will clear out the lower part of the bowel, while the medicine sweeps everything down from the upper end.

Mode of Injection.—An enema-syringe should be used (see plate of Nursery Appliances). It is an oval elastic bag, with an opening at each end of the oval; from each opening proceeds an elastic tube. One tube ends in a long ivory nozzle for insertion into the bowel. The other end dips into a bowl of water. When the bag is compressed by the hand anything it contains is forced out through the nozzle; when it is allowed to expand it sucks up a fresh supply of water by the other tube, the movement of the water being directed by valves. Take a small bowl of tepid water, work the syringe for a little time till it is found to be in good working order, expelling a steady stream of water, unmixed with air, from the nozzle with each compression of the bag. Now oil the nozzle, and by a twisting movement gently pass it up into the child's bowel, using no force, and directing the point slightly backwards and to the left, the child lying on its left side in bed or in the nurse's lap. An ivory plate prevents it being pushed too far. Then gently but steadily squeeze the bag till the water has all passed into the bowel, then relax and let it refill, gently press again. *Take care that all the time the other tube—the inlet tube—is dipping below the surface of the water in the bowl, so that no air is sucked in.* Even in the case of quite a young child the quantity injected by two or three compressions of the bag is not too much, when it is desired to act well and quickly. With older children a small bowlful of water may be injected with perfect safety. Besides plain water, soapy water and salt and water are often used, one table-spoonful of salt to half a pint of water. The salt and water act quickly and energetically. When an enema-syringe cannot be obtained, a brass one with ivory point may be used. Glass syringes are rather to be avoided, and, if used, great care must be taken that the point is quite round and not sharp, and that it is not broken in the bowel.

The second thing that may be done for a child threatened with some illness that looks serious is to give it a special warm bath or wrap it in a warm pack.

To give **the warm bath** the water should be at a temperature of 98° Fahr., and it is best to test the heat by the thermometer rather than by feeling with the hand. The child should be set in the bath up to the neck, and a blanket fastened round the neck of the child, and sweeping round the sides of the bath should completely envelop bath and child. The child should remain in the bath for twenty minutes to half an hour, the heat being all the time maintained by frequent additions of warm water round the sides. The child may then be lifted up, rolled in the blanket already round its neck, and without any drying put into bed. After another hour, or even less if the child finds the blanket too disagreeable to let it rest, the child should be rapidly rubbed down, clothed in a warm flannel gown and carefully wrapped in the bed-clothes. Or the child may at once, on being lifted from the bath, be rubbed down, clothed in flannel and put to bed.

The warm pack.—The child is to be stripped naked and rolled in a half-sheet or half-blanket wrung lightly out of warm water. It should be kept so for an hour and then rubbed down, and its flannel night-gown put on. Young children grow restless by being imprisoned in the wet sheet. They are usually quiet if their arms are allowed out.

The benefit of the warm bath is that it brings the blood to the skin, it causes the blood-vessels of the skin to relax. They become able to contain more blood in consequence, and thus deeper parts are relieved of too great a quantity of blood. At the same time, if there is fever, the water used being of a considerably less degree of heat than the blood, heat is withdrawn from the body, and that has a soothing effect on the nervous system. If, as has been advised, an injection has previously been given and has produced free evacuations, the unloading of the bowels will have already acted in a similar way.

The blood will have been diverted from the head and central nervous system, and the calming effect of the bath or hot pack will be all the more perceptible because of this previous action.

Now these two methods of treatment of children are simple in the extreme, and if carried out with a moderate degree of intelligence are incapable of doing harm. They will often dispel from the child within a short time all the more alarming symptoms, and secure for it some quiet rest and sleep. Often a child, that late in the evening shows signs of some serious illness, if treated in this way, and if care is given to the diet, &c., as already directed, will appear perfectly well in the morning. Even if not, and even if the illness does go on, the child is in a much more favourable condition in relation to the future course of the illness than it would have been.

AFFECTIONS OF THE NEWLY-BORN CHILD.

Irregularities of Form in the Newly-born.

An irregularly shaped head is not infrequent as the result of severe labour, or the use of instruments, &c. It is frequently extremely elongated, perhaps badly flattened or pressed in at one side. No fear is to be entertained on this account. Within a few days the head will gradually return to the normal shape.

Tumours or swellings may exist on the back of the head or at other parts of the head. **Spina Bifida** is the name given to a tumour occurring at the lower end of the backbone, due to an arrest of the growth of the bone, and protrusion of the membranes and other parts of the spinal cord in the shape of a bag. It is in many cases amenable to skilled treatment. Such swellings must not be interfered with by the mother or nurse. They are carefully to be guarded from injury or pressure. Spina bifida is much less serious than the similar condition of the head, and children born with it may be otherwise well-formed and healthy. A pad should be carefully adjusted and fixed over the swelling so as to maintain all over it a moderate degree of pressure.

Defects in the Opening of the Bowel or Urinary Passages sometimes exist. They should at once be brought under the notice of the medical attendant.

Hare-lip.—Hare-lip or split-lip occurs on the upper lip, the split being on one side of the middle line or the other, or on both sides. It is due to an arrest of development. For the upper jaw is formed by parts from each side growing inwards towards the middle line. They do not meet in the middle, but in the gap left growth takes place of an intermediate part which in time unites completely with the parts on each side, and thus the complete upper jaw is formed. This intermediate part it is which in the developed condition carries the four front teeth. Now hare-lip is an arrest of the growth at one period or another, the result of which is that complete union is not effected at one or other side or at both. The split may involve the soft parts only, or it may extend through to the bone. In the most extreme cases the central part of the upper jaw, including the bone and soft parts connected with it, is quite ununited with the rest of the upper jaw at each side. Often this central portion is projected forwards and upwards, standing straight out from the face, and sometimes it is so much twisted to one side as to block one nostril, out of which it seems to be sticking. In such cases the palate is cleft also, that is, the roof of the mouth is deficient in the middle line, owing to an arrest in the development of the bone, which should have grown forward till junction and complete union was effected in the middle line.

Cleft-palate in slight cases only involves the soft parts at the back of the mouth, the uvula, &c. (Fig. 136, p. 263). As it extends forward it involves the bone, till in extreme cases the cleft passes from back to front. There is thus no separation between the cavities of the mouth and nostrils.

When hare-lip exists alone, bone union being complete, the deformity is the only thing, and it can easily be remedied by an operation, which will leave little or no hint of the original condition. But when it is associated with non-union of the bone it interferes with suckling. This may sometimes be remedied by the mother using a nipple shield with a large nipple. When, however, the split is large and cleft-palate also exists, suckling is impossible, and even feeding is very difficult. Cleft-palate may exist alone to a greater or less extent. In many cases it is not noticeable till the child begins to speak, and then it is recognized by the peculiar nasal "twang." Both conditions can be remedied by operations. For hare-lip the operation should be performed before teething. It is not attended by danger, and its results in improving the appearance are remarkable. For cleft-palate there

is no haste, but it should not be delayed till the child has learned to speak and has acquired the "twang." It is not nearly so simple an operation as the former. In extreme cases the separation may be too great to permit of closure by operation, but a plate may be made to cover the opening.

Blue Disease (*Cyanosis*) is due to an arrest of development interfering with proper aeration of the blood. While the child is still in the womb its own lungs are inactive and unexpanded. The aeration of the blood of the child is effected indirectly through the blood of the mother. The blood of the child passes in the vessels of the cord to the placenta, which connects the child to the mother, and is there purified by exchanges with the blood of the mother. Returning from the placenta the blood of the child passes to the upper chamber of the right side of the heart, partly directly and partly through the liver. In the adult the right and left sides of the heart are separated by a complete partition, but in the fœtus an opening exists through which the pure blood can pass directly through the right upper chamber to the left, and from the left side it is then distributed through the body. After birth this opening should close, and then the blood requires to pass from the right side through the lungs, where it is purified, before it reaches the left. In rare cases this opening remains unclosed, and thus while part of the blood passes through the lungs to the left side, part escapes directly from right to left without previously passing through the lungs, and thus without aeration. The blood is, therefore, constantly deficient in oxygen, and the blueness arises in consequence. The child's skin, its cheeks, lips, hands, and feet are markedly livid, the fingers and toes are clubbed and the nails are incurved. It breathes rapidly and is liable to attacks of breathlessness. In marked cases death usually occurs in a few days, in slighter cases life may be prolonged for some years. All that can be done is to keep the child quiet and to protect from cold.

Tongue-tied. — This condition is due to shortening of the bridle of the tongue. When it is present the child cannot push the tongue out over the lips; and it interferes with the suckling. It is easily set right by turning up the tongue and dividing the front of the bridle by means of a blunt-pointed pair of scissors. This should only be done by a medical man, for if the scissors be directed upwards one of the blood-vessels running along the under surface of the tongue may be injured.

Cataract. — Children are sometimes born with white spots in the lens of the eye, interfering with sight, or the whole lens may be white, rendering seeing impossible. This is due to some defect of nourishment in the womb. The child should be taken early to an oculist, as an operation is frequently necessary very early to prevent changes arising in the eye that would interfere with the usefulness of an operation at a later period. (See p. 374.)

Diseases of the Newly-born.

Ulceration or Bleeding at the Navel.—If the bleeding be from the attached piece of cord it should be tied a second time nearer the belly. This may occur some hours after birth because the cord has been improperly tied. The clothing should be immediately undone and the cord tied again between the former place and the belly. Four or six strands of linen thread form the best material for the purpose. It may also occur owing to the remains of the cord being too early separated. If so, the bleeding is best stopped by gentle steady pressure with the finger or a small pad. It should not be allowed to continue, else the slow drain may be very hurtful. If the part be not healing properly, it should be carefully sponged frequently, and if necessary may be painted with an astringent like syrup of tannin, or tannate of glycerine.

Inflammation of the Eyes.—One form of inflammation of the eyes of a newly-born child, if not watched with great care, may ruin the child's eyes in the course of a few days, and render the infant incurably blind. It begins usually about the third or fourth day after birth. The eyelashes stick together, and the borders of the lids are red and crusted. Both eyes are attacked, the one after the other. The lids become swollen, and in a day or two thin fluid pours out of the eyes, the fluid in about a week has changed to matter, with which the eyes are constantly overflowing. The treatment consists in keeping the eyes scrupulously and constantly clean. Use warm water, and a soft rag or lint: *open the eyes thoroughly, turning out the lids, and cleaning away every particle of matter.* To the warm water a few drops of Condy's fluid, sufficient to make the water slightly pink, may be added. *This must be done*

not once nor twice daily but very often, so that no matter is allowed to accumulate in the eye. No ointments should be used. The inflammation, however, is of so dangerous a character in its effects upon the sight, that no time should be lost in having proper medical treatment.

Jaundice.—This is not uncommon during the first or second week of infant life, the skin and white of the eyes becoming quite yellow, and the stools colourless. It is not to be feared. Usually no remedies are required. It will pass off often as quickly as it came. If excessive give a small dose of castor-oil only.

Swelling of the Breasts.—This is not infrequent in newly-born children. The breasts are firm and tense, and occasionally fluid like milk oozes from them. *They should not be squeezed or pressed in any way.* Gentle rubbing with warm oil is often all that is necessary. Where redness or a purplish tinge indicates a more severe form of swelling, a soothing poultice of warm bread and water should be applied, or a warm sponge held on them each time the child is bathed.

Retention of Urine and Stools.—This may be caused by some defect already alluded to (p. 457). The nurse is never, by any means, to give "nitre" in the hope of causing the child to make water. She may use a warm bath, or place warm cloths over the lower part of the belly, and that usually will be sufficient. The attention of the medical attendant should be directed to the child if this is insufficient.

Moles and Mother's Marks.—These have been sufficiently considered on pages 247 and 322.

DISEASES COMMON TO CHILDHOOD.

Ailments at the Periods of Teething and Weaning.

The period of teething is undoubtedly a time when the child is easily upset, restless and highly excitable, and, therefore, more liable to ailments than at other times. But it is quite certain that to the teething process is attributed all sorts of trouble, due rather to careless nursing and bad management. In some cases the child is dosed with medicines of one kind or another, in other cases the excuse, "Oh! it is just the teeth," is given for every disturbance of health; and without much further thought the mother or nurse waits on time to remedy the ailment, when the teeth will all have been cut. Both methods are mistaken. It is not to be forgotten that the child is at a stage of development when it is in a peculiarly sensitive condition, but just for this reason more watchful care is to be exercised, and while medicines are avoided more attention is to be paid to good management. Disturbances of stomach and bowels are common, looseness of bowels especially. These are to be met by careful nursing and dieting, as indicated on p. 460. The same careful management will diminish the restlessness and excitability of the child. If, however, the bowels being free and regular, the child is much disturbed, mothers often feel they must give something to calm and soothe. Again it is necessary to repeat the warning against so-called soothing syrups, given on p. 447. One drug, however, may be given to calm the nervous system, and it is devoid of danger. It is bromide of potassium. Let 32 grains be dissolved in a little water and made up to one ounce, that is eight tea-spoonfuls, with simple syrup. Of this a tea-spoonful is given occasionally, but not frequently repeated. Lancing the gums, so often resorted to, is as a rule a barbarous practice, and is never done by modern physicians, unless the gum over the coming tooth is distinctly red and angry looking, and the tooth near the surface.

Inflammation of the gums does justify the procedure, and is greatly relieved by it, and that even though the tooth be not yet near the surface. The inflammation is readily known by the swollen state of the gum, and its dark-red appearance. In such a case, when the tooth is yet deep in the gum, the lance should be applied to the side and not over the coming tooth. For if the wound heal before the tooth is cut the scar is likely to make the cutting of the tooth more difficult.

At the period of weaning disorder of stomach and bowels is frequent. This difficulty may also be overcome by management. If the child's bowels are very troublesome, the mother had better delay the process for a little and then try again, or effect it very slowly.

Coughs, Colds, and Affections of the Chest.

Cold may take the form of running at the nose—**snuffles**—(preceded by frequent sneezing), watery eyes, some degree of feverishness, and the child is cross. This is a form of what is called "catarrh," from two Greek words

meaning "a running down" (see p. 154). It may extend from the nose to the throat, causing it to become red and swollen, may pass down into the windpipe, and may also cause a similar condition in the stomach, called catarrh of the stomach. In these severer forms there will be loss of appetite, white tongue, and if the child can speak it may complain of headache and pains in the back or limbs. Whether the attack be mild or severe, simple treatment is all that is required, that is, give the child a warm bath, keep it warm in bed, give gentle opening medicine—castor-oil—at once, let it be fed on slops, and give thrice or so daily 5 to 10 drops ipecacuanha wine. If the nose is very much obstructed some relief may be given by laying over it a sponge squeezed out of hot water. This is all the treatment that should be adopted without medical advice. This affection may, however, go on, the lungs may become affected and bronchitis or other disease of the chest result.

Bronchitis (p. 270).—This will be attended with quick, hurried breathing, with flushed face, and other aggravated signs. The ear applied to some part of the chest may detect wheezing or piping sounds. These are too serious forms of disease to be delayed over, and medical aid should speedily be secured. The treament advised on p. 271 may be adopted for children to the extent of applying a hot poultice occasionally to the affected side of the chest, and using the bronchitis-kettle, a constant stream of steam being poured in the neighbourhood of the child's cot.

Cough is present in most of the above affections, and is to be treated as described for cold. But, not infrequently, especially when the back part of the throat is evidently red and congested, the cough may be very irritating and even suffocative. This is often relieved, in addition to the means already mentioned, by putting a small, mild, hot poultice on the front of the neck, just over "Adam's apple," and giving repeated small doses of ipecacuanha wine, and if necessary by using the steam from a kettle as noted above.

There is a cough, however, which should rouse instant intention, a hoarse muffled cough "like the distant bark of a puppy," or a cough with a ringing metallic sound—a brassy cough. Let the mother or nurse be on guard against croup, of which this is strongly suspicious. (See p. 418.)

Affections of the Mouth, Stomach, and Bowels.

Thrush.—In this disease the tongue and inside of the mouth are covered by white patches of a peculiar growth, sometimes forming a continuous white crust. It is often accompanied by disordered stomach and bowels, particularly if the child be weakly. The patches are really due to the growth of a minute microscopic plant, flourishing because of the unhealthy state of the digestive canal.

Treatment. (1) Give mild opening medicine —magnesia with a little rhubarb. (2) Correct at once any errors in diet. (3) Apply to the mouth borax and honey, or glycerine with an equal part of solution of borax, or chlorate of potash (20 to 30 grains of either to an ounce of water). The disease will not be properly cured unless the disordered stomach is set right by proper dieting.

Ulcers on Lips and different parts of the mouth occur readily in children whose stomach and bowels are in bad condition. Treatment is the same as for thrush.

Inflammation of the Mouth of an extremely serious kind is seen in weakly, ill-fed children, living in large towns, in badly-aired apartments. It frequently follows on measles or other weakening disease. It begins as an ulcer, of a dirty ash-gray colour, on the lip or inside of the cheek, and eats its way into the cheek and gums. The face is swollen, saliva dribbles from the mouth, the breath is foul-smelling, and the teeth may drop out. The pulse fails, the stomach and bowels become disordered, and death results, often very rapidly, from exhaustion.

Treatment requires first of all to be directed to cleanse the stomach and bowels by a dose of rhubarb and magnesia. Nourishing food must be freely supplied, but in small quantities given often, milk and beef-tea specially. Wine is frequently needed to combat the feebleness. A mixture of chlorate of potash, 60 grains, syrup, 1 ounce, and water, 3 ounces, should be obtained, of which one to two tea-spoonfuls should be given every four hours. The mouth should be bathed with a solution of 30 grains chlorate of potash to 1 ounce of water.

Derangements of the Stomach and Bowels.—These are oftenest due to improper feeding; they also are frequent at periods like teething, weaning, and so on. They may be due to excessive quantity of the milk or altered

quality. If the child be at the breast it may have been too frequently suckled, or owing to some condition of the mother, or some improper food taken by her, the quality of her milk has been changed. This can be easily remedied. If the child is not at the breast the quantity and kind of food it is getting must be seen to. Similarly too sudden weaning, or irritation due to teething, may be the cause. If the cause can be discovered let it be removed at once, and probably, without further steps, but simply under the influence of proper food, given at proper intervals and in the right quantity, the child will be restored.

Vomiting is one sign of stomach derangement. If the child vomits the milk, unchanged, soon after taking it, and is immediately well and cheerful, *it has had too much.* Therefore let the quantity and frequency of suckling be diminished. Or if the child vomits frequently and looks pale and exhausted, is fretful and whining, and never easy unless when at the breast, sucking greedily and never satisfied, here again there is indigestion, caused also probably by improper dieting. If regulating the feeding in the ordinary way (p. 441) does not allay the irritability of the stomach, stop altogether giving the ordinary quantities, and give very small quantities of milk—one or two tea-spoonfuls—at intervals of twenty minutes or half an hour, for a considerable number of hours, or till the vomiting ceases. Then gradually increase the quantity and lengthen the intervals, till ordinary quantities are given every three or four hours. A warm poultice over the stomach will also help. Vomiting, persistent no matter what or how little is taken, occurs in disorder of the stomach from cold. If the plan already advised, one or two tea-spoonfuls at a time and at brief intervals, and warm applications over the belly, does not arrest it, then let some ice be obtained. A few pieces should be put into a glass of fresh milk, and the whole allowed to stand till the milk is ice-cold. Of this give the child a tea-spoonful, or at the most two every half-hour or so, and apply warmth outside. After the lapse of some hours give the iced milk less frequently, and give one or two tea-spoonfuls of ordinary milk between the doses. The irritability will almost certainly yield to this method, and gradually larger quantities of ordinary milk at longer intervals may be given. *It is needful to avoid giving any considerable quantity of the iced milk at a time, for that would be hurtful.*

Colic and Flatulence are manifested by the infant suddenly becoming fretful. It draws up its legs towards the belly and cries for a time, and then returns to its usual state. This is repeated on another attack. The distress may be great and the pain long, shown by the long-continued screaming and violent movements of the legs, and it may be relieved by a discharge of wind or stools. Here, again, look to the food the child is receiving. Get rid of any irritating matter by giving a dose of castor-oil, after which magnesia in doses of 3 to 5 grains, or fluid magnesia, one to two dessert-spoonfuls, may be given occasionally if required. When the colic is present rubbing the belly with the warm hand, or applying hot cloths will relieve it. The only other remedy that the mother or nurse should use is dill-water, of which half to one tea-spoonful is sufficient, or essence of anise, 5 drops on sugar.

Diarrhœa.—This may be of a simple kind in which merely the number of motions is increased. Such looseness is often the result of the irritation of teething, or the result of weaning, and is not to be regarded with alarm, though it is to be watched. Changing the diet entirely will often suffice to stop it. Thus instead of cow's milk give goats' or asses' milk, or condensed milk; or, if this does not succeed, stop milk entirely and give thin arrowroot made with water, weak chicken or mutton broth, &c. Frequently the addition of lime-water to the milk (a table-spoonful or so to a cupful of milk) may check the diarrhœa, or 5 drops of ipecacuanha wine in a tea-spoonful of dill-water every hour or two if the looseness is continuous. *Laudanum should on no account be given by a mother or nurse.* Even a single drop has been the cause of a child's death. As regards beef-tea and broths it is to be noticed that if given strong and in any quantity they rather encourage the looseness. Therefore let them be given weak and in small quantities at a time; and further to check the tendency to increase the looseness it is well to boil the beef-tea or broth with sufficient corn-flour to thicken it slightly. Besides the simple form of diarrhœa there are others in which the motions are greenish, slimy and offensive, and passed with straining, accompanied by great pain and exhaustion, the purging being attended by vomiting.

Looseness due to an inflammatory condition of the digestive tract, an **intestinal catarrh** (see p. 162), is attended by symptoms of this kind.

Infantile cholera or summer diarrhœa of children is also of this description. It usually begins suddenly with vomiting of milk little changed and with the passage from the bowel of greenish-yellow material, flaky, and containing lumps of undigested food. The child is restless, pained, as evidenced by the movements of the legs, and cries for and greedily drinks water. The motions become watery and colourless, and so much fluid is passed from the body in a short time that the child becomes excessively exhausted, with pinched dusky face and hollow eyes. This is a very dangerous kind, for the child may die exhausted in a comparatively short time. No delay in getting medical advice should be suffered in such severe forms. Till this can be got the ordinary diet should be stopped. The child should have plenty of cold water to drink, and should be permitted to suck small pieces of ice. The belly should in all cases be kept warm, and much may be done by rubbing or applying warm cloths, or a hot poultice made of equal parts of mustard and flour should be applied over the belly. At the outset it is well to give a single dose of castor-oil to clear away any irritating material. The following mixture may then be used:—

Aromatic Spirit of Ammonia...quarter of an ounce.
Ipecacuanha Wine................50 drops.
Subnitrate of Bismuth...........24 grains.
Mucilage and Syrup, of each...1 ounce.

Mix, and give a tea-spoonful every two hours as required.

White of egg beat up in water and slightly sweetened may also be given to drink. To meet exhaustion 5 to 15 drops of brandy in water may be given every half-hour or hour as seems necessary. It is exceedingly dangerous to give laudanum in such cases, and as a rule it should be given only by the medical man himself. If, however, the case is urgent, and medical advice not obtainable at the time, *a single drop* may be added to the brandy and water if the child is a year old or nearly so. This may be repeated in two or three hours if deemed necessary, but not a third time without advice. Should the child fall into a natural sleep it is probably a good sign. When the acute stage is passed, milk should be given in small quantities, to which lime-water has been added, and the milk should first be boiled.

Chronic diarrhœa, which occurs between weaning and the end of teething, is best met by the use of raw beef if the changes in diet advised at the beginning of this article are not sufficient. The beef is scraped into a pulp and mixed with salt, sugar, or fruit-jelly, and rolled into little balls or given as a sort of paste. Small quantities are given at first, and gradually increased till a child may take a quarter of a pound of meat so prepared daily. The only drink allowed is white of egg in sweetened water. After a time the ordinary diet may be gradually restored. To avoid the danger of worms the best meat should be obtained.

Intestinal Obstruction as it occurs in children is in the form of **intussusception,** in which one part of the bowel slips into another part, as one part of the finger of a glove may be made to slip into the neighbouring part. It is met with in infancy and early childhood, the male child being more liable to it than the female. It is occasioned by irregular action of the bowels, sometimes set up by improper food, by the presence of worms, or by diarrhœa. It is very liable to be misunderstood, the illness being taken for an attack of colic or diarrhœa, for though proper motions are not passed, a bloody discharge is.

The **symptoms** arise suddenly with very severe pain, readily causing convulsions. Vomiting soon occurs, and the *vomit is often streaked with blood, and in a short time becomes smelling of fœcal matters.* Severe straining at stool is present, and a bloody discharge is passed without proper motions. On examining the belly the mass of obstructed bowel may be detected as a sausage-like swelling. The child may die in a few days of shock or exhaustion.

The **treatment** must be prompt. Vomiting of material from the bowel and the discharge of blood should lead to help being instantly obtained. *Purgative medicines do harm.* The mother or nurse may, by means of an enema syringe, inject into the bowel, slowly and carefully, thin gruel or thin starch. This may be done in large quantity in the hope of releasing the obstruction by filling the bowel, and so causing it to slip up out of its unnatural position.

Costiveness.—It must be noticed that some children are costive by habit, and have motion only once in two or three days. It must also be remembered that frequent dosing with medicine is itself productive of costiveness, and is otherwise injurious. Medicines should therefore be avoided as much as possible, and reliance placed on proper dieting and on training the child to regular habits, to train it to seek relief at, as nearly as possible, the same time every

day, say after breakfast. Changing the diet is often as valuable for costiveness as for diarrhœa. When some form of medicine is necessary castor-oil or manna may be used. A simple treatment is to cut a piece of yellow soap into the shape and half the length of the little finger and push it gently up for 2 or 3 inches into the bowel, and there allow it to remain till it excites the motion. If two or three days have been allowed to pass without the child securing a motion it may be necessary to inject one or two syringe-fuls of tepid water as directed on p. 456. When castor-oil is given for costiveness it is well, instead of giving it now and then, to give a small quantity at the same time each morning for a good number of days, and when the bowels are regular the quantity should be gradually diminished till finally it is stopped altogether.

Worms.—These may often be prevented by the careful avoidance of improper kinds of food, and by proper seasoning of the food with salt. They are often introduced with animal food. Great care should, therefore, be exercised in the thorough cooking of all butcher-meat, especially pork, ham, and sausages. They are of three kinds —(1) Tape-worm passed in pieces like flat white tape, (2) round-worm, and (3) thread-worm. They, and all the symptoms they produce, have been sufficiently described on p. 167 and following pages. It is specially thread-worms that affect children. The best treatment is 1 to 3 grains of santonin given in the morning in cream, and some hours afterwards repeated injections of tepid water, in every half-pint of which a table-spoonful of salt has been dissolved, serve to bring them away. Steel-wine or a tonic of some kind should thereafter be given to the child, as well as good food, as debility favours the presence of worms. For the method of injection see p. 456.

Falling of the Bowel. — This may arise from debility, from diarrhœa, or from costiveness owing to straining. It is to be prevented by getting the child into a proper state of health, relieving the costiveness, or checking the diarrhœa. *The bowel must not be allowed to remain down.* To return it bathe the part gently with cold water, form the fingers into a cone and embracing the part gently push it upwards.

Rupture. —This may occur at the navel within a month or two after the child's birth. It is a swelling which increases with crying or straining. It is caused by a portion of the bowel being forced through the little opening at the navel under the skin. The bowel must be kept within the belly by a small firm pad, secured by a bandage. Rupture in the groin shows a swelling in one or other groin passing downwards and inwards to between the legs. It may exist at birth or be brought on by straining, coughing, or crying. The bowel should be returned at once into the belly, and a proper truss obtained for keeping it constantly in place.

Bed-wetting (*Incontinence of Urine*).—This is a frequent affection, and is due very often to the presence of some irritant in the bowels, such as worms, or about the private parts. Careful search should, therefore, be made for such a cause. Attention should be given to the diet to avoid an irritating quality of the urine. Only simple food should be given, pastries and such things being avoided, and simple drink also, milk or water. Before going to bed each night the child should be set down in a warm salt-water bath, covered with a blanket, for 10 to 20 minutes, and should be roused several times during the night to empty the bladder. It is also recommended that the child should be prevented sleeping on its back by some simple contrivance, such as binding on a thread bobbin. If these measures fail, a doctor should be speedily consulted, lest the habit become confirmed. Mothers should be careful that children are not punished for what may be a weakness rather than a fault. If a doctor is not easily obtainable, let the child get 2 to 4 drops of tincture of belladonna in a little water before going to bed.

Spasmodic and Nervous Diseases.

Convulsions may be due to disordered stomach and bowels, caused, for instance, by too much food, or by improper food (unripe fruit, raw carrots, turnips, &c.). They may be due to teething, constipation, worms; they occur sometimes at the beginning, or during the course, of some diseases, such as scarlet fever, &c., and they are frequent in diseases of the brain, such as "water in the head." They may be slight or severe, from mere twitching of face to those accompanied by staring eyes, distorted features, and violently agitated or rigid limbs. Convulsions are readily caused in children because of the nervous matter of the spinal cord being very excitable in them, owing to the controlling action of the brain being not yet well developed. Any irritation, therefore, conveyed to the spinal cord is readily communicated to nerves passing to various groups of muscles, and a stimulus is

thus quickly conveyed to the muscles causing them to pass into a state of rapid contraction. Now the commonest irritation is that derived from the bowels because of the presence of some undesirable material, improper food, or undigested masses of food for example.

The period of teething is also an age liable to convulsions, not only because of the constant irritation, but also because at the time the child's nervous system is in a highly excitable condition. The treatment is twofold (*a*) during the attack, and (*b*) preventive. (*a*) Loosen the child's clothing: dash cold water in its face, or on the chest. A mere sprinkling of water is of no use: a good quantity should be thrown straight on the child. Immerse the child up to the belly in a warm bath, and apply cold to the head. If the cause is suspected to be in the stomach give a dose of ipecacuanha wine to cause vomiting, from a tea-spoonful upwards according to age: if in the bowels give an injection according to directions given in p. 456. In any case an injection is most valuable. Salt water may be used for the injection, or soap and water, or castor-oil and warm water. (*b*) Correct errors in diet: if the gums are highly inflamed and seem to be the cause, lancing will relieve them. Frequently convulsions indicate very serious brain mischief, and therefore the advisability of at all times consulting a doctor.

Night-terrors, in which a child starts up from sleep shrieking and in a state of extreme terror, are commonly caused by irritation through undigested or indigestible food. Care in the management of food, already so often advised, and attention to the bowels, will prevent their recurrence.

Spasm at the head of the Windpipe—Child-crowing—False Croup.—The child is suddenly seized, and frequently during sleep, with spasm that prevents the entrance of air to the lungs; the face becomes swollen, red, and then bluish, owing to the great difficulty of breathing. The child is extremely agitated, and there seems a tendency to convulsions. In a short time the spasm yields, the air rushes in with a long crowing noise, and the child falls back pale and exhausted, and becomes in a short time composed as if nothing had happened. The fit may recur and may, if prolonged, cause death by suffocation. It is a nervous disease, and occurs owing to nervous irritability. The irritation may be from teething, or the child may be so excitable that a slight fright may occasion it. Use cold water as recommended in convulsions, and allow plenty of fresh air. A hot foot-bath with mustard, or a warm bath for the whole body is also useful. While the child is in the fit, forcibly open the mouth and pull forward the tongue, grasping it by a handkerchief between fingers and thumb. As a preventive, bromide of potassium, in doses from 2 to 5 grains, with 5 drops spirits of ether or tincture of valerian is useful. Examine the teeth and watch the bowels, so that any cause of irritation may be removed.

St. Vitus' Dance or Chorea is discussed on p. 125.

Water-in-the-Head is considered on pp. 101 and 102.

Paralysis as it sometimes attacks children is discussed on p. 122.

Fevers and other Infectious Diseases.

These have already been discussed elsewhere.

Scarlet Fever, - - -	Refer to p.	399
Measles and German Measles,	,,	400
Typhus Fever, - - -	,,	410
Typhoid Fever, - - -	,,	411
Small-pox, - - - -	,,	402
Chicken-pox, - - - -	,,	410
Whooping-Cough, - - -	,,	416
Diphtheria and Croup, - -	,,	417
Mumps, - - - - -	,,	153

Scrofula and Consumption.

Refer to pages 431 and 282.

Mothers who are concerned about the delicacy of some child should take special pains in guarding and rearing it, after the manner suggested on pages 282 and 431.

Skin Diseases.

Skin diseases have been sufficiently discussed in Section XI., page 311 and following pages. In general they are to be treated by dieting, attention to the bowels, and frequent use of the bath and carbolic-acid or tar soap.

Nettle-rash.—See p. 314.

Red-gum Rash.—See Lichen, p. 319.

Tooth-rash is similar to the above, and to be treated in the same way.

Scalled-head. See Eczema, p. 318.—It may, however, be noted here regarding this skin affection that it is attended by the formation of "watery heads," which leak, are very itchy,

and give rise to yellowish-green scabs. It occurs often on the head, ears, nose, &c. The scabs should be got rid of by warm poultices of soft mashed turnips. Bathing with warm water to which a pinch of soda has been added will relieve the itching. When the scabs have been *completely* removed, the ointment mentioned on p. 319 should be used; or better still a new ointment called chrisma sulphur. The child's system should be strengthened by cod-liver oil, chemical food, &c.

Running Ears should be treated by gently syringing the ears twice or thrice daily with lukewarm water (see p. 382).

Rickets.

Refer to p. 30.

Bow-legs are to be prevented by treatment similar to that for rickets.

Accidents.

Scalds and Burns.—Remove the clothing as carefully as possible. Put the child in bed and see that it is warm. Arrange a box, wire-guard, or other similar contrivance over the burned part to keep off contact with bed-clothes. Under such an arrangement the injured part is to be kept free from cloths, cotton or other material, while at the same time kept warm. Paint the part, by means of a feather, with a mixture of equal parts of raw linseed-oil and lime-water. This is very cool and soothing if freely and frequently applied. In every house a bottle of this mixture should be kept, and quickly painted on the slightest burn or scald. Should a child's clothing take fire, throw over it a shawl, blanket, or other woollen article, and so smother out the fire. If the mouth or throat have been severely scalded, let ice be sucked till medical aid is obtained.

Wounds and Bruises.—If the wound is clean cut, bathe with cold water. This, with gentle but firm pressure, will stop bleeding. Remove any dirt or other foreign matter; bring the edges together accurately and keep them there with plaster and a bandage. To bruises apply cold-water cloths *if it is attended to at once.* This prevents swelling of the part. Any swelling, blueness, &c., which may result can afterwards be got rid of by aid of warm-water cloths. For wounds and bruises a recent remedy is very valuable, the extract of witch-hazel. It is sold in America as Pond's Extract. The writer has found it of great value for *external* application.

Sprains.—Rest is the main treatment. If the sprain receives immediate attention, surround the parts with cloths wrung out of iced water. This keeps down the swelling and relieves pain. Later, or if the cold applications are disliked, apply warm cloths. When all pain and inflammation have quite passed away, *but not till then,* rubbing with or without liniment will help to restore the use of the part.

Falls on the Head should receive careful attention. The child should be put to bed and keep quiet for the day. He should also receive a large dose of purgative medicine, castor-oil or syrup of senna. Cold cloths should be kept to the head and only milk diet allowed. If the child is cold warm bottles should be applied to the lower limbs, and the body gently rubbed, *but no stimulants of any kind should be given.*

Bleeding from the Nose may be controlled by the application, over the bridge of the nose, of sponges soaked in cold water. If it occurs frequently without known cause, let the child's health be inquired into. If it is a stout, evidently full-blooded child, keep the bowels free, and let the diet be very simple. If, on the other hand, the child is delicate, it should have an iron tonic, like chemical food, and cod-liver oil, and plenty of nourishing food.

Foreign bodies in the Nose and Ears, &c.—(1) If the body is in the nose, the child should be made to take a deep breath, then the free nostril closed, and a strong effort to blow through the blocked nose will often succeed in dislodging the substance. (2) If the body is in the ear, syringing may be used if *the body is not a pea or a substance that can suck up the water and swell.* Pins, bodkins, &c., should be used with the utmost care, especially in the ear, where a slight thing will injure the delicate drum of the ear and destroy the power of hearing on that side. (3) If a child has swallowed a pin, a coin, or other foreign body, purgative medicines should not be given, nor much fluid food, but plenty of soft food, like porridge, rice, corn-flour, saps, &c., which may surround the body and prevent it injuring the stomach or bowels.

Choking.—If a piece of food has stuck in the throat, support the child's head by the left arm, open the mouth with the handle of a spoon or a piece of wood, pass in the forefinger well to one side of the mouth against the cheek and push it right back into the throat. By sweeping the finger round, the mass may be hooked out.

SECTION XVI.—RATE OF GROWTH OF CHILDREN.

Period and Rate of Growth in Children:
The Value of Periodical Measurements.
Standards of Growth:
Tables showing Height, Weight, &c., at different Ages—
(1) in boys and men of the artisan class,
(2) in girls,
(3) in boys and men of the most favoured classes.
Comparison between Growth of Boys and Girls, and between Growth of Boys of different Classes.
The Relation of Height to Weight—Tables showing Increase in Weight corresponding to a certain Increase in Height.

Period and Rate of Growth in Children.

In the last section the management of children from birth up to a few years of age has been entered into in some detail. It is not necessary to follow up that section with one considering the management of children from the earlier years to the age of manhood or womanhood. The lines on which such management should proceed are practically similar in both instances. For details regarding food, clothing, exercise, &c., reference can be made to the part of the work devoted to Hygiene, from which full information can be gleaned. Investigations undertaken in recent years, however, have shown that parents and guardians of children have always at hand a simple and reliable means of informing themselves of the general state of physical health and growth of the children under their care, a means of assuring themselves that their method of watching over the bodily well-being of the children is attaining its purpose. This means consists in observing accurately, from time to time, the growth of the children in height and weight.

A large number of statistics shows that up to the age of about 22 years in boys and 18 in girls an uninterrupted increase in height occurs in a state of health, accompanied by a regular increase in weight. The rate of increase varies with the year of life, and, indeed, also with the season of the year. Moreover, a multitude of observations has shown that for each year of life there are a certain height and weight and a certain rate of increase which can be set down as the standard for that year. Diseased conditions, whether apparent or not, seriously affect this normal increase. Any wide departure from the general rule, if not actually in every case indicative of disturbance, becomes at least a signal of possible danger and a warning of the need of careful inquiry into the state of health. Here, then, is a valuable means, ready to the hands of parents and all who are in charge of children, of assuring themselves from time to time of the general health of their children and of the results of their management of them.

For the proper carrying out of the method a register requires to be kept. The name of the child is entered, and opposite each observation the date should be written. At regular periods, say at intervals of one month, the height and weight should be measured and duly noted. The height is measured from the sole of the foot to the crown of the head; shoes are, therefore, removed. The weight ought not to include clothes; and as the amount of clothing varies at different times, it is well to take the weight with clothes and shoes, and then weigh these separately, deducting their amount from the total. Besides the height and weight the measurement round the chest is valuable. It should be taken next the skin—without clothing, that is to say. The measuring tape is placed quite horizontally round the chest. The lower edge in front touches the upper part of the nipple and includes the lower part of the shoulder-blades behind. To ensure that the chest is always expanded with air to the same extent the person is made to count from one to ten, when the measurement is taken. The arms should, at the time, hang loosely by the sides.

The Value of such Periodical Measurements is shown by a variety of circumstances. Dr. Percy Boulton gives one instance that occurred at the Boys' Home, Regent's Park: "In 1875 it was found at that institution that the boys had not increased on an average 2 inches a year, so, in January, 1876, a revised dietary was used, and it was found after one year that, by this simple change, the average increase amongst the boys had been over 2 inches in stature and 6½ pounds in weight." In prisons and lunatic asylums the inmates are weighed once a month, and the information given by the scales is taken as an indication of the sufficiency of the diet in quantity and quality. But the

information is of further value. If the weight is not satisfactory, and no error in diet accounts for this state of affairs, an examination of the person is made. As a result maladies are discovered in an early stage, before other signs had made themselves manifest; and thus disease is detected at an early stage, when it may be more easily and successfully treated. It has been shown that loss of weight is one of the earliest occurrences in consumption, and may be detected before cough has begun.

Everyone knows that young people who are growing rapidly are, as a rule, more easily fatigued and can stand less bodily and mental strain than others. If regular measurements were taken and showed that a rapid increase in height was taking place, unaccompanied by a corresponding increase in weight, it would be a sufficient warning of the necessity of care and avoidance of undue exertion both bodily and mental. A boy or girl who exhibits rapid bodily growth, cannot be expected to exhibit the same mental activity as one whose energies are not so much diverted in one direction. Allowance ought, therefore, to be made in the former case for less progress in education and less inclination for school work. In such a case parents and guardians ought to refrain from endeavouring unduly to push school work, and ought rather to encourage open-air amusements and exercise. The reverse condition of unusual cleverness and devotion to books and school work, accompanied by diminished growth in height and weight, would be equally taken note of as undesirable, and instead of the mental application being applauded and encouraged it would be restrained until the verdict of the measuring rod and the scales was more favourable.

It has been very strongly urged by those who have devoted special attention to the functions of the brain and nervous diseases that such methods of regular measurement ought to be systematically employed by schoolmasters and all who have to do with the regulation of the education of children, and that physical growth rather than age ought to be the indication of the stage of progress in education. Such observations would show that mental dulness was often healthy, and would aid in distinguishing between pupils who were backward because of bodily conditions and those who were backward because of idleness and carelessness. They would also show that brilliance at school was often unhealthy and undesirable, and in need of careful restraint rather than encouragement.

Standards of Growth.

In order to obtain any benefit from the weighing and measuring of children, one must know what ought to be the height and weight of the child at particular ages, so that the ascertained height and weight may be compared with that which is taken as the standard in health. This standard has within recent years been supplied by very numerous observations made upon children and grown-up persons at various ages. Tables constructed on the basis of these observations will be given. The tables given are derived from Dr. Roberts' *Manual of Anthropometry*. At the top of each column of the table is noted the year of life, and below are given the mean height, the mean growth occurring from one year to the next, the mean weight and its mean growth from year to year. It is necessary to explain that mean height, mean weight, &c., imply the height, weight, &c., which were found to be the most common among the multitudes examined.

TABLE I.

Showing the Mean Height, Mean Weight, their Annual Rate of Growth, and the Mean Chest-girth, with its Annual Increase, of 13,931 Boys and Men between the ages of 4 and 22 Years, of the Population in Large English Towns—Artisan Class.

Age last Birthday.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21 to 22
Mean Height (in inches), ..	38·5	41·0	43·0	45·0	47·0	49·0	50·5	51·5	53·0	55·5	58·0	60·5	63·0	64·5	65·5	66·0	66·25	66·5
Mean Increase in Height, ..	—	2·0	2·5	2·0	2·0	2·0	1·5	1·0	1·5	2·5	2·5	2·5	2·5	1·5	1·0	0·5	0·25	0·25
Mean Weight (in pounds), ..	44·0	50·0	54·0	57·0	59·0	62·0	66·0	70·0	74·0	78·0	84·0	94·0	106·0	116·0	122·0	128·0	132·0	136·0
Mean Increase in Weight, ..	—	6·0	4·0	3·0	2·0	3·0	4·0	4·0	4·0	4·0	6·0	10·0	12·0	10·0	6·0	6·0	4·0	4·0
Mean Chest-girth (in inches), ..	—	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	26·0	27·0	28·5	29·5	30·0	30·5	31·0	31·5
Mean Increase in Chest-girth, ..	—	—	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	1·0	1·0	1·5	1·0	0·5	0·5	0·5	0·5

Note.—The height is taken without shoes, but the weight included clothes (which are taken to equal 7 to 10 lbs.).

TABLE II.

Showing the Mean Height, Mean Weight, and their Annual Rate of Growth of 10,904 Girls, between the Ages of 5 and 18 Years, attending the Public Schools of Boston, U.S.A. (Bowditch).

Age last Birthday.	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mean Height (in inches), ...	41·0	43·5	45·5	47·5	49·5	51·5	**53·5**	**56·0**	**58·0**	**60·0**	61·0	61·5	62·20	62·0
Mean Increase in Height, ...	—	2·5	2·0	2·0	2·0	2·0	**2·0**	**2·5**	**2·0**	**2·0**	1·0	0·5	0·5	—
Mean Weight (in pounds) including clothes, ...	40·0	44·0	48·0	52·0	56·0	60·0	**66·0**	**76·0**	**88·0**	**96·0**	104·0	110·0	112·0	114·0
Mean Increase in Weight, ...	—	4·0	4·0	4·0	4·0	4·0	**6·0**	**10·0**	**12·0**	**8·0**	8·0	6·0	2·0	2·0

Table II. is derived from Dr. H. P. Bowditch, and the girls were partly of American, Irish, and mixed English, Irish, and American parentage.

It is necessary to notice the difference between the physical conditions of the boys and men of Table I. and the girls of Table II., else erroneous conclusions would be drawn. The boys of Table I. belong to the artisan class, living in large English towns. They are, therefore, not in circumstances best fitted for natural and unimpeded growth. They are statistics of boys subject to the more or less constant influence of at least not quite healthy surroundings, bad air, not too abundant nourishment, and labour begun in early youth, just at the period when growth ought to be most rapid. The girls of Table II., on the other hand, belong to a more favoured class, at least including many of the more favoured classes, likely, therefore, to show statistics of better stature and weight.

In order to show the differences in growth due to more favourable physical conditions of life, Table III. is given, dealing with boys and men of the most favoured classes, as found in English public schools, in the army, navy, universities, and medical schools. Thus Tables I. and III. will afford standards for boys and men, whether belonging to the artisan or more favoured classes, and Table II. will afford a standard for girls. Tables II. and III. will also permit a more reliable comparison to be drawn between the growth of girls and that of boys.

TABLE III.

Showing Mean Height, Mean Weight, Mean Chest-girth, and Mean Annual Growth of 7709 Boys and Men, between the ages of 10 and 23 Years, belonging to the most Favoured Classes of the English Population (Roberts).

Age last Birthday.	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mean Height (in inches),	53·0	54·5	56·5	58·5	**61·0**	**63·5**	**66·5**	**68·0**	68·5	68·75	69·0	69·0	69·0	69·0
Mean Increase in Height,	—	1·5	2·0	2·0	**2·5**	**2·5**	**3·0**	**1·5**	0·5	0·25	0·25	—	—	—
Mean Weight (in pounds) including clothes=9 pounds,	67·0	73·0	80·0	88·0	**98·0**	**110·0**	**126·0**	**140·0**	146·0	148·0	150·0	152·0	—	—
Mean Increase in Weight, ...	—	6·0	7·0	8·0	**10·0**	**12·0**	**16·0**	**14·0**	6·0	2·0	2·0	2·0	—	—
Mean Chest-girth (in inches), ...	—	—	27·5	28·5	29·5	31·0	33·0	34·0	34·5	34·75	35·0	35·25	35·5	35·75
Mean Increase in Chest-girth, ...	—	—	—	1·0	1·0	1·5	2·0	1·0	0·5	0·25	0·25	0·25	0·25	0·25

Comparison between Growth of Boys and Girls, and between Growth of Boys of Different Classes. Comparing first of all Table I. with Table III., it is evident that the boys and men represented in the latter are in a better physical condition than those of the artisan class. At the age of 21 the most favoured class has a mean height of 2½ inches greater than

the artisan class. The tables afford no means of comparison below the age of 10 years, but at that age the most favoured class has still the advantage of 2½ inches. At the age of 16 the difference in height between the two classes is as much as 3½ inches, due to the very rapid rate of growth about that age among the favoured classes, among whom it is greatly reduced in the 18th year, while in the artisan class the greater rapidity of growth does not begin so soon, does not go on so quickly, but lasts a year longer, so that the great difference in height at the age of 18 becomes reduced during the succeeding year. These differences are undoubtedly due to the less fortunate circumstances of the artisan class, which not only diminish the rate of growth but actually lessen its total amount. Similar differences are exhibited in respect of weight and chest-girth. At 21 years of age the artisan is a mean of 16 pounds lighter than his more favoured neighbour. At 10 years of age the difference is only 1 pound, but it is gradually and steadily increased, and the most favoured class have a permanent advantage of some 14 pounds in weight. In chest-girth at 21 the artisan is nearly 4 inches less than the youth of the non-labouring class.

A perfectly accurate comparison between the growth of girls and boys is not obtainable from the tables, for the girls belonging to Table II. were not drawn exclusively from one class. But the table shows that girls attain their full height earlier than boys by between two and three years, namely at 17 years, and that their mean height is from 4 to 7 inches less than men. Even at birth there is a difference in height and weight between male and female children to the advantage of the former. The difference in weight between the two sexes and in chest-girth is also marked. What is specially worthy of note, however, is that it is between the 11th and 13th years that growth is most rapid in girls both in height and weight. After 14 growth, which began to lessen the year before, rapidly diminishes, and is reduced to very little after 16. This rapid falling off in growth is coincident with other changes of great importance discussed at length in Sect. XVII.

In the tables the figures between the years when growth becomes most rapid and then falls off are given in black type for the sake of emphasis.

The Relation of Height to Weight. It is of importance to notice that increase in weight should occur in a regular way with increase in height. The following table is given by Dr. Percy Boulton in the *Lancet* of Oct. 16, 1880, as a reliable working standard. It is deduced from the results of observations of the same children who were examined at least once annually. The children were selected as average children of healthy well-to-do parents, brought up with suitable food and surroundings, giants and dwarfs being excluded.

TABLE IV.

SHOWING THE RELATION BETWEEN HEIGHT AND WEIGHT (BOULTON).

A child of	3	ft.	0	in. should	weigh	2	stones	8	lbs.
,,	3	,,	1	,,	,,	2	,,	10	,,
,,	3	,,	2	,,	,,	2	,,	12	,,
,,	3	,,	3	,,	,,	3	,,	0	,,
,,	3	,,	4	,,	,,	3	,,	2	,,
,,	3	,,	5	,,	,,	3	,,	4	,,
,,	3	,,	6	,,	,,	3	,,	6	,,
,,	3	,,	7	,,	,	3	,,	8	,,
,,	3	,,	8	,,	,,	3	,,	10	,,
,,	3	,,	9	,,	,,	3	,,	12	,,
,,	3	,,	10	,,	,,	4	,,	0	,,
,,	3	,,	11	,,	,,	4	,,	2	,,
,,	4	,,	0	,,	,,	4	,,	4	,,
,,	4	,,	1	,,	,,	4	,,	6½	,,
,,	4	,,	2	,,	,,	4	,,	9	,,
,,	4	,,	3	,,	,,	4	,,	11½	,,
,,	4	,,	4	,,	,,	5	,,	0	,,
,,	4	,,	5	,,	,,	5	,,	2½	,,
,,	4	,,	6	,,	,,	5	,,	5	,,
,,	4	,,	7	,,	,,	5	,,	7½	,,
,,	4	,,	8	,,	,,	5	,,	10	,,
,,	4	,,	9	,,	,,	5	,,	12½	,,
,,	4	,,	10	,,	,,	6	,,	1	,,
,,	4	,,	11	,,	,,	6	,,	3½	,,
,,	5	,,	0	,,	,,	6	,,	6	,,

The general conclusions will best be given in Dr. Boulton's own words. "I find," he says, "that average English children, brought up under favourable circumstances, grow from 2 to 3 inches a year. *A growth of less than 2 inches or over 3 should excite apprehension.* The former would indicate arrested development, and the latter a rate of growth beyond the powers of average children. Rate of growth should be regular, and, being so, prognosticates future stature, because the healthy child that grows 2 inches a year passes 5 feet at about 15, which indicates a short stature (*i.e.* if a male about 5 feet 6 inches, female about 5 feet 1 inch). The healthy child growing 2½ inches a year is 3 feet 2 inches at 3 years, and passes 5 feet at 13 to 14 years. Such child will be a medium-sized adult (*i.e.* if a male about 5 feet 8 inches, female about 5 feet 3 inches). The quick-growing healthy

child that accomplishes 3 inches a year passes 5 feet at 10 or 11, and eventually makes a tall adult (*i.e.* if a male about 5 feet 10 inches, female about 5 feet 5 inches). . . . Of course one meets with many variations, but these variations are, I believe, always abnormal. Some children seem to do their growing by fits and starts, the common diseases of children arresting, for the time, their progress, which is made up for afterwards by a supreme effort. Such growth is unnatural and often very detrimental. I believe, then, that every healthy child has its own regular rate of growth of 2, 2½, or 3 inches a year, from which it has no right to vary more than ¼ inch a year."

"Next as to weight for height, whether a child grows 2, 2½, or 3 inches a year, weight for height should be, in each case, identically the same; and all children should grow broad in proportion to their height. *Between* 3 *and* 4 *feet the increase in weight should, I find, be* 2 *pounds per inch, and between* 4 *and* 5 *feet* 2½ *pounds per inch.*" . . .

"Some children exceed these weights (those given in Table IV.) that are by no means giants, and really healthy, well-nourished children of healthy parents and favourable surroundings generally attain these averages. But what of children that fall below the standard? I find that there is a 7-pound margin of safety, and that children falling more than 7 pounds below this standard are devoid of reserve capital on which to draw, and, consequently, they succumb quickly to many constitutional diseases. This, therefore, may be called the preventive-medicine margin, beyond which lies the dangerous land of cachexia" (a depraved condition of body).

"Arrest of growth or loss of weight precedes so many diseases that it may be looked upon as a danger signal; and, if the caution is noticed before the disease point is reached, catastrophe may frequently be prevented."

These tables are given as standards for reference, and brief suggestions will be given in closing this section as to their method of use.

Each child should be weighed and its height taken once a month, or at least once a quarter. Reference should then be made to Table I. or III. in the case of boys, according to the class to which the child belongs, the labouring or more favoured class, or to Table II. in the case of girls. It will thus be seen whether the child reaches the standard for its age. The column of the table is taken headed with the age of the child at its last birthday; and in that column will be found the height, weight, and chest-girth to which it should reach. The results of each weighing and measuring should be noted in a book kept for the purpose, the date being accurately entered. The increase that has taken place since the last trial should be noted and compared with the standard in the tables. Lastly, the height of the child should be referred to Table IV., and it should be noticed whether the weight reaches to that mentioned in the table as proper to the particular height.

Of course there will be variations. Any considerable variation, however, and specially any sudden variation, should lead to careful consideration of all the child's circumstances, its food, the fresh air and exercise obtainable by it, the amount of school and other work, &c. Some change in these may at once be suggested. If no such circumstance seems to account for the departure from the rule, medical advice should be sought.

Especially between the ages of 11 and 17 should the results of the weighing-chair and measuring-rod be carefully watched. They will throw light on the question of over-pressure at school, and, if their warning is accepted, will do much to prevent it. Every school ought to have a room set apart and equipped for the weighing and measuring of the pupils. The standards of weight and height should be painted on the walls, and each pupil's height, weignt, and chest-girth should be registered at regular periods. Education would then have a better chance of being conducted on physiological principles, and with some regard to the physical development of the pupils.

SECTION XVII.—HEALTHY WOMANHOOD AND THE DISEASES OF WOMEN.

Healthy Womanhood.

The Dress of Girls:
- *The Conditions of Healthy Dress;*
- *The Common Errors in Girls' Dress*—The evils of stays and the deformities they produce;
- *Suggestions as to Healthy Clothing.*

The Education of Girls:
- *Higher and University Training*—Opinions of various authorities in England, America, and France.

The Female Generative Organs:
- *The Womb* (uterus), *Fallopian Tubes,* and *Ovaries.*

Menstruation (*The Monthly Illness*):
- *Time of Appearance and Symptoms;*
- *The Change of Life;*
- *Vicarious Menstruation;*
- *The Management of the Monthly Illness.*

Pregnancy and its Management:
- *Conception;*
- *The Growth of the Offspring in the Womb*—The formation of membranes and after-birth (*placenta*)—Progress of growth at different months;
- *The Duration of Pregnancy;*
- *Signs of Pregnancy*—Stoppage of Monthly Illness—Morning Sickness—Changes in the Breasts—Enlargement of Abdomen—Movements of Child—Sounds of Child's Heart.
- *The Management of Pregnancy*—Food—Clothing—Exercise—Bathing—The Breasts—Medicine.

Labour and its Management:
- *The Stages of Natural Labour;*
- *The Duration of Labour;*
- *The Position of the Child in Labour*—Attitude—Presentation;
- *The Management of Labour;*
- *The Treatment of the Newly-born Child;*
- *The Treatment of the Mother after Delivery;*
- *After-pains;*
- *The Discharge.*

The Diseases of Women.

Affections of the Generative Organs:
- *Diseases of the External Parts*—Eruptions—Sensitive Red Patches—Itching of the Genitals—Inflammation—Boils and Abscess;
- *Diseases of the Vaginal Passage*—Inflammation—Discharges (*Leucorrhœa—whites*)—Fistula—Tumours and Growths (Cancer, &c.);
- *Diseases of the Womb*—Inflammation, Ulceration, and Tumours (Polypus, Fibroid, and Cancer)—Displacements and Falling (*Prolapse*) of the Womb;
- *Diseases of the Ovaries*—Inflammation, Neuralgia, and Tumours.

Disorders of the Monthly Illness (Menstruation):
- *Absence of the Monthly Illness* (*Amenorrhœa*);
- *Irregularity or Scantiness of the Monthly Illness;*
- *Excessive Monthly Illness* (*Menorrhagia and Metrorrhagia*);
- *Painful Monthly Illness* (*Dysmenorrhœa*);

Affections of the Bladder, &c., in Women:
- *Painful, Difficult, and Frequent Passing of Water.*

Diseases of Pregnancy:
- *Derangements of Stomach and Digestion*—Excessive vomiting, &c.;
- *Disturbances of Breathing;*
- *Disturbances due to Pressure*—Dropsy, Varicose Veins and Piles;
- *Nervous Affections;*
- *Miscarriage and Flooding;*
- *Molar Pregnancy or Blighted Mole.*

Diseases after Child-birth:
- *Flooding;*
- *Milk-Fever and Affections of the Breasts*—Gathered Breast:
- *Convulsions and Insanity;*
- *Puerperal Fever.*

Sterility.

Nervous Diseases of Women:
- *Hysteria, Catalepsy and Trance.*

HEALTHY WOMANHOOD.

In the preceding section statistics have been given showing the rate of bodily growth in weight and height of both sexes. From these tables also it will be observed that in girls, between the ages of eleven and thirteen, increase in height and weight becomes more rapid than at any other period of life, while growth begins to diminish at thirteen years of age, and at the age of sixteen it begins to cease. A similar occurrence is evident in the case of boys, but several years later. This comparatively sudden falling off in physical growth is coincident with the attainment of the period of puberty. Puberty is derived from a Latin word, *puber*, signifying of ripe age, or adult. The age of puberty is the period when the development of certain organs, devoted to the function of reproduction, so advances that the person becomes capable of discharging that function. As this period arrives the energies, formerly devoted mainly to the building up of the general bodily structure, become largely diverted, and the increase in height and weight is thus rapidly diminished. It is just previous to the arrival of this period that the marked increase in stature and weight occurs. Both these occurrences are indications of critical stages in the life history of the individual. The period before puberty, the *prepuberic period*, as it is called, is a time when the nutritive processes of the body are in a condition of high activity, as is sufficiently indicated by rapid growth, and the equally rapid falling off in growth is also indicative of profound constitutional changes. Both are periods which make exceptional demands on the bodily powers, and which are, therefore, attended by risks of their own, specially so in girls in whom the changes connected with this stage of life are more rapid than in boys. It is a time of instability, a time when all the powers of body and of mind are sensitive to slight influences and easily overbalanced. It will be well, therefore, to indicate briefly what suggestions physiology has to make to parents and guardians to aid them in their appropriate guidance of girls under their charge. First of all, and in general, reference may be made to the last section where the advisability is urged of observing, at periodical times, the rate of growth in height, and the relation of height to weight, as indicative of the condition of bodily health and vigour. Any marked variation from the standard there given should lead to more detailed examination of the state of health, and if need seem, to an examination by the family physician to ensure that nothing is wrong. In this respect girls and boys are to be treated in the same way. Some special remarks are called for, however, in regard to the dress and education of girls.

THE DRESS OF GIRLS.

Conditions of Healthy Dress.—Strictly speaking there is only one purpose of dress, and that is to maintain the whole body at an appropriate and equal degree of heat. That main purpose being fulfilled, there are various secondary conditions to be kept in view. The dress ought to be light so that the bodily energy is not taxed to carry about an unnecessary weight, and it ought to be so adapted to the body as to leave unhampered all the natural movements of the body. This second condition implies not only that the movements of the limbs shall not be restrained, but also that such movements as those of breathing shall in no way be impeded, and that, as another example, no part of the clothing shall so constrict a part as to interfere with the natural flow of blood in it. The main purpose of clothing being fulfilled in accordance with these conditions, it is time enough to consider how the dress can be made graceful or becoming.

Common Errors in Girls' Dress.—It is easy to point out how the ordinary dress of women and girls breaks the above rules. It is not arranged so as to keep the whole body equally warm. There is more clothing over the hips than on any other part of the body. All the underclothing leaves the neck and shoulders practically bare, and when they are covered it is only by the bodice of the dress. Unless the sleeves are tight-fitting the arm is really exposed up to the elbows, while, owing to the looseness of the skirts, the legs from the knee downwards are insufficiently protected. If the clothing is improperly distributed as regards warmth, it is as apparently improperly distributed for purposes of easy carriage. The heaviest portion of it hangs from the waist, and the weight itself necessitates the drawing of the garments tight that they may be properly supported, so that the one evil leads to another. On the other hand, garments dependent from the shoulders are easily borne, and entail no undesirable constriction round the waist. A third point in which female dress is strikingly at variance with the conditions of healthy dress is in its undue weight. It will be admitted that the total

weight of the clothing is out of all proportion to the degree of warmth that it is required to maintain, and that if only warmth and protection are to be taken into account, much of it is superfluous. Thus the weight is not only badly arranged for easy carriage, but it is excessive in amount. This becomes a very important question in relation to exercise. The addition of one or two pounds weight needless clothing may seem a trifling affair, but when one considers the bodily energy expended in carrying these few pounds a distance of a few miles, it is easily seen that that slight extra weight may be indeed a serious burden, even in the ordinary movements of locomotion, and becomes an unconscious hindrance to free and vigorous exercise. Custom prevents this being fully appreciated, but women themselves know well how weighed down they feel when walking with clothing wet with rain. The increase in weight is not much, but it is felt as a load, just because it is more than they are accustomed to. Perhaps female dress does not err, from a healthy standard, more grievously than by the undue restriction of movement which it enforces. It is needless to say that the movements of the legs are very limited, and that running or jumping would be accomplished with difficulty. Tight sleeves seriously press on parts, especially at the armpits, and impede the circulation in the arm; garters, by their pressure below the knee, offer a very considerable obstacle to the return of blood in the veins from the parts below, and directly encourage the production of dilated veins with all their attendant evils.

The Evils of Stays, and the Deformities they produce.—These mistakes are as nothing to that of tight-lacing, and the evils they produce are small in comparison with those that attend this larger and greatest of all evils of feminine dress. The real effects of tight-lacing ought to be thoroughly considered. First of all, it undoubtedly impedes the full expansion of the lungs. In the section on Respiration it is explained (p. 254) that the act of breathing consists of an expansion of the chest in every direction; the cavity of the chest enlarges and air rushes in to fill up the lungs, and so occupy the increased space: thereafter the chest returns to its usual size, and air is thus expelled to permit of a diminution in the expansion of the lungs to fit the diminished space. The chief way in which the chest cavity enlarges is by the descent of the diaphragm, which is at once the floor of that cavity and the roof of the cavity of the abdomen or belly. When the diaphragm descends it does so at the expense of the belly cavity, on whose space it encroaches, and to make additional room the front and side walls of the abdomen bulge outwards. Now if the waist and part of the chest are encircled by a tightly drawn and, by the agency of steel, practically unyielding structure like stays, this movement of the abdominal walls cannot be developed, the descent of the diaphragm is arrested, and expansion of the chest in this direction becomes difficult. To compensate for this, enlargement must take place by exaggerated raising and widening of the upper part of the chest through movements of the ribs. The lower part of the chest is restricted in movement, and in the upper part the movement is overdone. The lungs are thus insufficiently and improperly inflated, in their upper portions having to bear an unnecessary strain, and their lower portions being seldom properly distended at all. Moreover, the constant pressure exerted by the stays forces inwards the lower ribs and specially the last two on each side, the floating ribs, which have no attachment in front, and forces in to some extent also the lower ribs next to them, so that the shape of the chest becomes actually altered, and instead of being broad and expanded low down, it is narrowed and drawn in. All this means diminished breathing space, enfeebled breathing power, and its indirect consequences it is difficult to estimate. But more than this. The pressure exerted by tight stays seriously alters the proper positions of the various organs in the abdomen. It is difficult to state with any accuracy how many different kinds of disturbance of a good state of health may arise in this way. The normal circumference of the waist ought to be from 25 to 27 inches. Under the influence of lacing this may be reduced to 20 or 22 inches, and even less, 16 inches being considered by some fashionable dressmakers the goal to be reached. Now all this constriction takes place at the expense of the space within the abdomen, and partly within the chest; for, as has been stated, the lower ribs are easily compressed from the slight nature of their attachments in front. Now in the ordinary condition every inch of space is occupied by the various organs, and the compression can only be exercised at their expense. The stomach, bowels, and liver will be directly affected, pressed together to some extent, and also to some degree forced upwards or downwards. This undue pressure tends to prevent full growth of the parts, and even if they have previously been fully developed, some degree of wasting

(atrophy) or shrinking. After death the liver on examination has been seen to bear permanent marks of the ribs pressed on it by tight-lacing. For even though the pressure is relaxed every time the corsets are removed, the continuous daily recurrence of the compression gradually establishes a permanent state of constriction, so that the parts do not return to their normal size on removal of the pressing force. It is undoubted that indigestion, disturbances of the liver and bowels—even ulceration of the stomach—have been the results of the persistent practice of wearing tight stays. Besides being themselves directly affected in this way, these organs, according to the amount of displacement they are bound to experience, alter the relations of others. Pressed upwards they encroach on the space that ought to belong to heart and lungs, breathing is disturbed, and the natural action of the heart interfered with. Palpitation, faintness, and many other heart symptoms may be the direct consequences. Then the pressure exerted downwards inconveniences the bladder, and is a very frequent cause of altered positions and disordered functions of the special female organs. Displacements of the womb, with all the manifold influences they may have on the monthly illness, are recognized as often produced by such a cause as this. While such evils as these result from the practice, what benefits, it may be asked, are supposed to be derived from it? It can hardly now be maintained that the "taper-waist" is desirable from its beauty. Any standard of beauty as regards human form is derived rather from that which appears to be most perfect in its development and most natural in its outlines. Greek statuary shows with perfect distinctness the views held by the ancients on the subject. The Venus of Melos shows the natural outline of the waist, and is a model of what its sculptor must have esteemed an ideal of beauty. The wood-cut in the text, taken from a photograph, while it sufficiently indicates the outline, cannot suggest the dignity and grace which the statue itself so wonderfully exhibits. Let anyone compare this outline with that given to the female form in any fashion-plate, and there ought not to be much difficulty in admitting that the "taper-waist" is, strictly speaking, a deformity artificially produced. It is urged, however, that stays are necessary to distribute the weight of the clothes and to give some support to the back. As to distributing the weight of the clothes, it has been already indicated that the suspension of so many clothes from the waist, which is supposed to necessitate the use of the corset, is itself a grave mistake, and there can be no doubt that the clothes can be so adjusted from the shoulders as to render any such artifice as stays unnecessary. As to the need of supporting the back, that is rather the effect than the cause of stays. For the fashion in which, even from infancy, children

Fig. 182.—The Venus of Melos, showing the natural female form.

are hedged in, from the hips to the arm-pits, by a more or less stiff wall, is undoubtedly productive of feeble development and deficient vigour of the great muscles which run right down the back on each side of the back-bone. It is one of the first laws of growth that moderate and regular exercise of a part of the body strengthens that part; in short, that its strength is in proportion to the use that is made of it, and that, on the other hand, disuse of a part inevitably

tends to weakness and wasting. Now the swathing to which infants and young children are subjected so restrains the activities of the muscles of the trunk that proper exercise of them is impossible, and the corsets of later years even more effectually impede their activities.

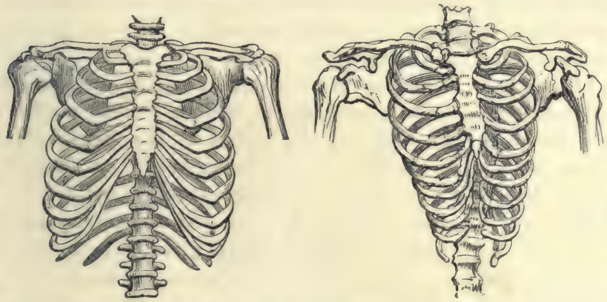


Fig. 183.—The Bony walls of the Chest.—That to the left shows the natural position, that to the right the deformed position due to tight lacing.

It is therefore the stays that render the back weak, not the weakness of the back that renders the stays necessary.

Suggestions as to Healthy Clothing.— These are some general criticisms meant to point out the errors, from a point of view of health, in the general character of woman's dress. It is only women themselves, however, who can successfully carry out any reform in this direction. Fashion is too imperious to bow to the authority even of health, and, probably, the necessary reforms will not all be carried out till the time arrives when health becomes fashionable. But even though the outward appearance of woman's clothing must be regulated, not by a question of comfort and physical well-being, but mainly by the whim and caprice of the rulers of fashion, every woman has it in her power, while submitting to the fashion-makers, to adapt her clothing in order that it may fulfil more thoroughly than it usually does its obvious purposes. That is to say, if a woman must conform to what other people wear in the matter of a cloak or a jacket, a bodice and skirt, and if she must cut her bodice in accordance with the mood of the times, and adorn her skirt with furbelows or frills as the newest style directs, she can at least exercise her own will as to the nature of that portion of her clothing which is not meant to be visible. Underclothing consistent with health is not a very elaborate affair. There ought to be a garment next the skin made of wool or flannel, shaped to fit easily. A knitted "suit" would probably be the most useful. It should reach up to the neck, fitting it as close as is comfortable, and ought to be provided with sleeves down past the elbow, also easy fitting. The lower part of this combination garment would extend below the knee. Over this linen garments might be put on according to the pleasure of the wearer, but they ought not to be made with that exuberance of material, both in length and breadth, which is customary, and which necessitates so many creases and folds and doublings. Thus a chemise might be made with some respect to the length and circumference of the body it was designed to clothe. Any petticoat ought not to be simply fastened round the waist, but ought to be suspended by something like braces from the shoulders, or by buttoning on to a light bodice. But if any additional *heavy* underclothing is required for more warmth it ought to approach as nearly as possible to a divided garment that will cover each leg separately. Such *light* petticoats as are worn for appearance need, of course, no such division. Now it cannot be said that underclothing of such description as this demands anything in the nature of stays, for there is no great weight in it, and what weight there is is borne from the shoulders. Stays, therefore, ought to be entirely discarded as an article of dress, of whatever description they may be, for children, girls, and young women. It may be admitted, however, that nursing mothers require more support to the breasts than ordinary clothing supplies, and that for them some form of corset is required. But this ought rather to be in the shape of a bodice made of stouter material than usual, and such a bodice could be readily made without the steel bands and other stiff structures of which ordinary corsets chiefly consist. Women who have naturally more largely developed breasts than usual could adopt such a form of support as would easily meet the requirements of comfort and appearance. This healthy form of underclothing that has been suggested, if it were adopted, need not interfere with the wearing of a dress and its bodice made according to the requirements of the times, and thus health and fashion would each have a due amount of regard paid to them.

As regards covering for the feet and legs, woollen stockings ought to be worn, but the usual method of securing them by garters round the knee is highly injurious. Any garter to be

sufficiently tight for this purpose must press on the veins of the surface, and thus impede the circulation in the skin. This obstacle to the free upward flow of blood from the foot and leg causes an accumulation of blood in the veins; the pressure of blood becomes so increased that the walls of the veins are apt to yield, especially in older persons, and varicose veins or a swollen and inflamed condition of the skin are in time the results. They often lead also to a feeling of weariness and pain, just owing to the interference with the circulation. The stockings ought, therefore, to be secured by suspenders connected with the shoulder brace or bodice. The form boots and shoes ought to take is considered under HYGIENE.

It cannot be too strongly impressed upon mothers and those who have the charge of girls that attention ought to be paid to the clothing of girls, to ensure that the purposes of clothing are carried out, and are not carried out in any way that is inconsistent with the highest degree of health and healthy growth. Many of the most serious evils of a woman's life, and an innumerable number of the minor ailments, that seem little in themselves but nevertheless among them make the difference between an active, bright, and energetic woman, and an ailing and feeble woman, are the result of mistaken notions in clothing of which the woman was the victim during the period of childhood and youth. Grown-up women may dress themselves as they please, and may violate the laws of health, if they choose to sacrifice themselves to foolish notions of what is desirable in female form, but they are not entitled to humour their fancies in the dress of their children, if the methods they adopt are likely to hinder the healthy growth of the children, or tend even indirectly to encourage feebleness.

THE EDUCATION OF GIRLS.

Higher and University Training.—It used to be a common subject of discussion whether women are intellectually inferior to men, and it was also commonly concluded that they are. Whether that be so or not, it is a fact that woman was for many centuries kept in subjection, and that indeed it was not till the advent of Christianity that woman was called to occupy her position as not the inferior but the complement of man. If there is any truth in heredity, this long-continued subjection must be taken into account, and the suggestion of the old question that girls should not receive so complete an education as boys, because they are unfit for it, must be set aside.

Without attempting a logical definition, we may say that education has as its objects the leading out or developing of all the powers of mind and body; and even if it were admitted that woman is mentally inferior to man, that is only an additional reason for more careful, and complete, and well-adapted training. Linked with man in life's work, and one with him in destiny, why should woman be less carefully prepared for the duties of life or less fitted for its issues? Accordingly, now as complete an education is being gradually extended to girls as is given to boys, and in America, where especially the education of girls has been pushed with much eagerness, a university education is not debarred to them.

Opinions of various Authorities in England, America, and France.—Although sufficient time has hardly elapsed since this movement began its full swing to enable one to estimate accurately its effects, nevertheless a very considerable body of testimony is put forward to show that girls are not only fitted intellectually for the highest developments of education, but are not necessarily injured physically. Thus Mrs. Henry Sidgwick, speaking of her experience at Newnham and Girton Colleges at Cambridge, says, "the experience of Girton and Newnham certainly shows that the danger need not be alarming. The actual number of women who even temporarily break down at Cambridge from the effects of work is exceedingly small in proportion to the whole; and as for the average health of the hard-working students it is little to say that it would compare very favourably with that of girls who are laboriously devoting themselves to the pursuit of amusement. I think it may be asserted that it would compare favourably with the average health of young women generally in the class from which our students are drawn. In fact, overwork is an evil to which attention ought to be continually given, not so much because the danger of it is great, as because it is to a large extent preventible. A delicate woman may go, and frequently has gone, through the course of training for an honour examination without any injury to her health, and even with positive gain to it, from steady and not excessive work, with power, to a great extent, to choose her own days and hours for it; but even a strong one is liable to make herself ill unless she will observe the ordinary common-sense rules of health as to sleep, food, exercise, recreation, and other things."

Miss Freeman, President of Wellesley College, Massachusetts, judging from the experience of three colleges for women in the Eastern States of America, the Vassar, Wellesley, and Smith Colleges, where in 1883 there were more than 1000 women students, says the results have been "so manifestly good that they would go on, greatly trusting that in educating women's heads they would not hurt their hearts or ruin their constitutions."

Mrs. Richards of Vassar College offers proof of the possibility of giving girls a complete university education free from danger to health, in the shape of statistics concerning a large number of women who had studied and graduated at first-class institutions, and who had passed out of them from five to fifteen years before the date of inquiry. As a result of the inquiry "physicians had acknowledged that they were surprised at the comparatively good health of the educated women of America as shown by these statistics." According to Mrs. Richards, "experience had shown that if a girl was well cared for from twelve to eighteen, then went to college from eighteen to twenty-two, during that period there would be no trouble whatever." She hoped that those who had the control of education in this country (England) would look closely into that matter. It was, of course, very difficult to keep acquainted with those who had left college, but if some kind of record could be kept of their subsequent health, that would be the best answer which could be given as to the danger of the physical effect of education upon girls.

In France there is a magnificent college at Sèvres for women, the École Normale Secondaire Supérieure, concerning which Professor Darmesteter says "the system for the higher education of women had already produced good results, and he trusted that it was opening up a new era in the education of women." Similar testimony comes from Germany.

There is, of course, another side to the question. The modern objections to an education for girls as complete as that for boys centre round the opinion that such education unfits girls, by the nervous strain to which they are subjected, for their duties in life as wives and mothers. There is evidence in support of that opinion. Professor Loomis, of Yale College, regarding the increasing physical deterioration of American girls, says "the cry to our older colleges and time-honoured universities is: Open your doors that the fairer part of creation may enter and join in the mental toil and tournament! God save our American people from such a misfortune!" This, however, it is right to say, was the opinion of Professor Loomis at a much earlier period than the testimony in favour of university education for girls already given. Dr. Withers Moore of Brighton gave his address as President of the British Medical Association in 1886, on the subject of the higher education of women. He asks, "Is it for the good of the human race, considered as progressive, that women should be trained and admitted to compete with men in the ways and walks of life, from which heretofore (as unsuited to their sex) they have been excluded by feeling and usage, and largely, indeed, by actual legislation?" He answers that "it is not for the good of the human race, considered as progressive, that women should be freed from the restraints which law and custom have imposed upon them, and should receive an education intended to prepare them for the exercise of brain power in competition with men. And I think thus," he continues, "because I am persuaded that neither the preliminary training for such competition work, nor the subsequent practice of it in the actual strife and struggle for existence, can fail to have upon women the effect of more or less (and rather more than less) indisposing them towards, and incapacitating them for, their own proper function—for performing the part, I mean—which (as the issue of the original differentiation of the sexes) Nature has assigned to them in the maintenance and progressive improvement of the species. . . . This 'higher education' will hinder those who would have been the best mothers from being mothers at all, or, if it does not hinder them, more or less it will spoil them." Dr. Moore cites in support of his opinion the views of Herbert Spencer, Dr. Matthew Duncan, Sir Benjamin Brodie, the late Dr. Edward H. Clarke (U.S.A.), Dr. Emmet of America, Mr. Lawson Tait of Birmingham, and others, mostly specialists in diseases of women.

The general strain of these opinions will be sufficiently indicated by the following from the late Dr. Thorburn, of Owens College, Manchester: "The struggle for existence on the part of single women, and the capacity of a few of their number to ignore, with safety, the physiological difficulties of the majority, are demanding opportunities for education, and its honourable as well as valuable distinctions, which cannot and ought not to be refused. Unfortunately, however, up to this time no means have been found which will reconcile this with the physiological necessity

for intermittent work by the one sex. It becomes, therefore, the duty of every honest physician to make no secret of the mischief which must inevitably accrue, not only to many of our young women, but to our whole population, if the distinction of sex be disregarded."

If, however, we carefully consider the burden of the objections raised to the full education of girls, and the recent developments of female education in England and America, some way out of the maze created by these differences of authority seems possible. We have to consider that many women find the necessity of earning their livelihood in occupations requiring careful education and a large amount of mental toil, and we find a large and daily increasing number of women who value the highest education, not for what it will bring, but for its own sake. The claims of neither of these can be disregarded. Up to the age of twelve years there is no reason why girls should not receive an education equal to, if not identical with, that given to boys. It is after that age that difficulties arise due to the special circumstances of sex. It is about that age that special developments take place in the training of boys dependent upon their intended course through life. If they mean to go in for commercial pursuits, the education is moulded in accordance with that intention, if for professional life, they go on to training preliminary to the universities. If they are boys who, by reason of their position, can afford to pursue an education whose immediate object is culture, and whose ulterior object may be determined at a much later period, according merely to fancy or inclination, the higher education of the secondary school and the university is proceeded with. This age is also the time when, in the case of girls, the special circumstances dependent on her sex require to be taken into consideration. The Americans seem to find that if, after that age, whatever may have been the system adopted before it, the education of girls is directed with special regard to her physiological necessities, that is with regard to the monthly changes which periodically occur, all danger may be averted. This almost implies that girls be taught, after that age, in secondary schools set apart for themselves, where they do not enter into competition with boys, and where, on that account, a periodical relaxation of studies may be permitted to occur without throwing one set of pupils out of line with another in rate of study. Still further to diminish all tendency to overstraining, the best American opinion seems to indicate the advisability of abolishing competitive work and examination among girls, and it is found that the love of work itself supplies sufficient stimulus to requisite exertion, that, even where competition is not engaged in, the eager desire for learning requires careful watching to hold it sufficiently in check. Similarly colleges for women only, where like care and supervision are exercised, seem preferable to mixed colleges where an unhealthy straining to excel is almost certain to exist. Such a regulation of study, in accordance with girls' physiological requirements, is only possible in an institution exclusively devoted to girls.

Overpressure in education has as pernicious an effect on boys as it has on girls. That evil is got rid of by proper regulation of study, and, along with care in diet, &c., by means of a due amount of exercise and recreation. This general rule is applicable to girls as well as to boys. The special objection in the case of girls is that the *continuous* mental application is not consistent with the special demands made upon a girl's energies at regularly returning periods connected with her peculiar functions. That objection, we believe, is met by such provisions as have been already indicated, which, however, as we have already said, can only be properly made in secondary schools and in colleges devoted exclusively to the female sex, and regulated with due regard to these functional peculiarities. In short, the objections that have been urged against the according of the highest education to girls do not strictly lie against the education itself, but against the system on which it has been conducted. The arguments are not logically against giving the same education to girls as to boys, but against giving that education *in the same way*. We believe the difference in the testimony that came from America at an early period in the movement for higher education, which was not in its favour, and the later testimony, when better methods had been devised, and which was in its favour, is simply due to that fact that the necessity for periodical relaxation had not been recognized at the early period, and was fully realized at the later. Thus one teacher in giving evidence before the State Board of Massachusetts, in 1874, said: "*At certain periods* I think that study with girls should wholly cease for some days. I refer to girls from twelve to twenty years of age. Anyone who has taught boys and girls—in separate schools, I mean—must have noticed the greater proportionate irregularity of attendance of the latter, and as a parent he would know the reason

and the necessity of cessation from work." Another says, "Could the custom of keeping girls between the ages of thirteen and nineteen out of school and at moderate rest *during certain periods* become established among us, a certain number might suffer restraint not absolutely demanded, but the general result would be an incalculable gain to the health, present and prospective, of the inhabitants of this commonwealth." Dr. da Costa, of New York, maintains that "common sense and the teachings of physiology point in the direction of lessening, as far as practicable, work *at a time when the whole system is depressed*." Dr. Cohran of the New York State Normal School has been "compelled to the conclusion that the sexes cannot be educated *on the same system* with advantage, and that the physical disadvantages under which the female labours render it necessary that a system be devised so elastic, with so much optional work, that the female may rest, at least comparatively, *as the occasion requires*." Those parts of the opinions have been printed in italics, which show clearly that the objections taken are not to the higher education in itself, but to the difficulty of reconciling it with the periodical change in women, and that difficulty later methods have to a large extent overcome.

The conclusion of the whole matter seems to be, let girls have the same education as boys and along with boys, if need be, up to the age of twelve years, overpressure being carefully avoided in the case of one as in the case of the other, a due amount of recreation and exercise being daily insisted on; after that age deny not to girls secondary and university education, but let it be conducted in institutions restricted to them, but as fully equipped and conducted by as able teachers and professors as similar institutions for boys, where, however, periodical variations in the amount and degree of mental effort can be arranged for in accordance with the periodical variations in the amount of energy that can be devoted to nervous activity, with proper regard to other requirements. By such means the world will be blessed with wise and cultured women, and will not be without vigorous wives and mothers, not less capable of the highest duties of womanhood, because to the sweet instincts of nature they add the rich treasures of a cultured mind.

THE FEMALE GENERATIVE ORGANS.

At the age of from thirteen to sixteen years, in temperate climates, changes occur in girls which indicate that a stage has been reached in the development of special organs, and that the girl has become capable of her peculiar functions. The main change is the occurrence of a discharge from the genital organs, which, because of its recurring at regular intervals of twenty-eight days or one lunar month, has been called the "monthly illness." Before considering what the discharge means, it will be necessary briefly to describe the organs concerned.

The female generative organs situated within the body are the womb or uterus and certain appendages, the ovaries, and tubes which lead from them to the womb. The relation of these parts is shown in Fig. 184.

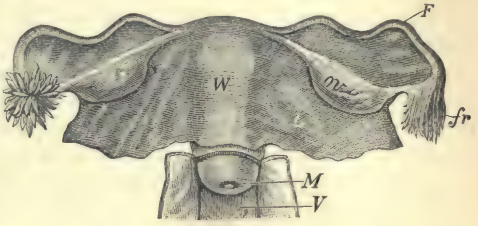


Fig. 184.—The Womb and its Appendages.

W, the womb. *ov*, the left ovary. *F*, the left fallopian tube, and *fr*, its extremity. *L*, the ligament of the womb. *M*, the mouth of the womb. *V*, the genital passage, opened up.

The womb or **uterus** is situated deep in the cavity of the pelvis (p. 22) between the bladder which lies in front of it, and the end of the large bowel which lies behind it. It is pear-shaped, and is on an average three inches long, two broad, and one thick. It is composed mainly of muscular fibre of the involuntary kind (p. 70). In its centre is a narrow cavity (the walls being very thick) running up towards the broad end of the pear-shaped organ, and opening at the narrow end at what is called the mouth of the womb. The inner surface next the cavity is lined with mucous membrane (p. 307), in which there are glands. The organ is richly supplied with blood-vessels and nerves. By means of a transverse slit, the lips of which are, however, in the virgin state closely applied to one another, the mouth opens into the passage of the vagina, which communicates with the outside, and is about 5 inches long. The womb is kept in position by ligamentous structures, which are lax enough to admit of a moderate degree of movement. Now the womb is flattened on its front and back walls, and if a pear be imagined as pressed somewhat flat in this direction it will be easily understood that the appearance of a corner at each side of the

broad end will be produced. The womb has such a corner at each side of its upper end, and from each of these corners a tube passes off, the **fallopian tubes.**

Fallopian Tubes. Each tube has the appearance of a thick cord, 3 or 4 inches long. It consists mainly of muscular tissue like that of the womb, and in the centre of its whole length runs a canal, the inner wall of the tube being lined by a membrane also like that of the womb, but having no glands imbedded in it. At the end next the womb the canal will admit only an ordinary bristle, but at its other end it is wider. The end distant from the womb opens into the cavity of the belly, is trumpet-shaped, and provided with fine finger-like projections or fringes. (See Fig. 184, *fr.*) The tube of each side is further connected with the womb by a broad band of tissue, a ligament. Connected with this ligament is the **ovary,** one on each side of the body.

The Ovaries are flattened oval bodies, each about 1½ inch long, ¾ inch wide, and nearly ½ inch thick. They are attached to the womb by means of the broad ligament referred to, and to one part of the ovary the fringe of the fallopian tube of its own side is connected. It is in the ovaries that the ova are produced,

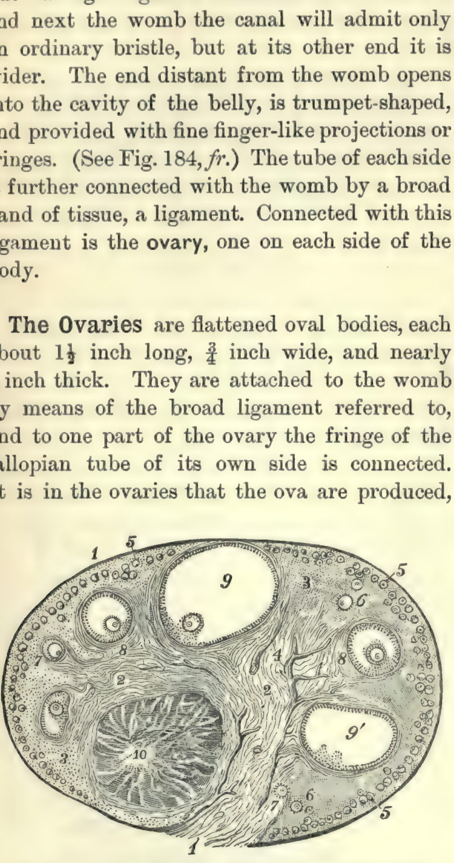


Fig. 185.—Section of Ovary magnified, showing ova in various stages of growth.

1, Capsule of ovary. 2, Fibrous substance of ovary. 4, Blood-vessels. 9′, Sac from which ovum has been removed. 10, Space from which ovum has been discharged filled up with blood-clot, &c. For meaning of other numbers, see text.

the female element in the production of new beings. The ovaries are supplied with many nerves and blood-vessels. Each ovary contains a multitude of ova or eggs in different stages of growth. In the ovaries of a female child at birth they are already visible, and it has been estimated that no less than 70,000 may be present in the two. Each ovum or egg is about the $\frac{1}{100}$th of an inch in size. Fig. 185 shows a section or slice of an ovary, the little round bodies being the ova, those near the surfaces (5) being undeveloped, those deeper (6, 7, &c.) being more mature. In process of growth the ova pass more deeply into the substance of the ovary. Instead of lying in groups, one becomes separated from others by growth of substance between them. As one becomes more mature it becomes surrounded by an envelope or capsule, which by and by forms a sort of bag round it. The ovum becomes attached to one part of the wall of the sac and fluid is produced separating the rest of the wall from it, and the fluid increases till the egg is, as it were, connected to the inner wall of a minute bladder. (See Fig. 185, 8 and 9.) As it grows, the sac with its ovum approaches near the surface of the ovary till it bulges from the surface. The continued increase of fluid finally causes the little bag to burst, and the ovum is discharged. The ovary at this time is very freely supplied with blood. The discharged ovum would readily drop into the cavity of the belly but for the fact that at this time the fringed end of the fallopian tube is applied to the ovary, and the ovum is received into the canal of the tube, and passes down the canal till it reaches the womb.

Thus during the early years of a girl's life the ovary is developing, and the ova it contains are maturing. It is not till the twelfth year or upwards that the first ovum becomes ripe and is discharged, and when that period is reached the girl has arrived at the age of puberty, that is, the age when she is capable of conceiving. At the time when an ovum is about to be discharged, changes take place in the womb; an extra supply of blood reaches it, and the changes occur which lead to the appearance of the discharge. From the time when the first ovum becomes mature and is discharged, as a general rule, one becomes ripe after another at intervals of twenty-eight days. Thus from thirteen years or so onwards regularly every month an ovum becomes mature and is discharged, and its period of ripening and discharge is attended by the changes in the womb alluded to, and so there is the periodical occurrence of the monthly illness. For a certain number of years—up to the age of forty-five or thereby—these changes regularly take place till the organs become exhausted, the period of the "change of life" arrives, these occurrences cease, and the capacity of conception has passed away.

MENSTRUATION.

Menstruation (*The Menses—Monthlies—The Periods—The Courses*) is the term applied to the process, whose external evidence is the discharge from the genital organs. The word is derived from the Latin *menstrualis*, meaning monthly, from *mensis*, a month.

Time of Appearance and Symptoms.—It is some time between the ages of twelve and sixteen years that the appearance of the monthly discharge indicates that the internal generative organs have arrived at some degree of maturity. Even before that occurrence various other signs indicate a change coming over the girl. An alteration takes place in the figure and gait owing to expansion of the hips and fuller and more rapid development of the breasts. The whole figure becomes more plump and rounded, and the girl less awkward and angular, and more graceful. Her manners also change. She becomes more sedate and less wayward, more timid and bashful, but also more gentle and loving. The actual period of the first illness varies with the climate and other circumstances. In Britain the age of sixteen is that at which it most commonly begins; in France it is earlier. The general rule is that it appears earlier in warm countries and later in cold countries, the mean being in a temperate climate. The date of appearance is also affected by the conditions of life. It is earlier among those who live in towns, and later among country girls. Luxurious habits of living, the use of warm stimulating foods, &c., hasten it; while among those whose lives are more simple and primitive, or who live among conditions of hardship, it is delayed. It is also influenced by the constitution, and its appearance may be long delayed in a delicate girl. There are also exceptional cases on record, cases where the illness has appeared remarkably early, or where it has not appeared for many years past the usual time. The first monthly illness is frequently accompanied or preceded by some degree of feverishness, pains in the back, a sense of fulness in the abdomen, and feelings of great weariness. It is also a time when a girl may manifest a variety of nervous symptoms, and may be liable to hysterical attacks. The first portion of the discharge is clear, later it is tinged with blood, and gradually it becomes almost pure blood, the blood then gradually diminishing till finally the discharge becomes free from blood and then ceases. The symptoms which preceded and accompanied the discharge pass off, and in a few days the girl is in perfect health.

The regular illness is not established all at once. The girl may suffer from some of the preliminary symptoms, which lead the mother to conclude her illness is going to begin, and after a few days they may pass off without any or but a very slight discharge appearing. And this may occur at one or two periods without any flow of blood. Or one illness may occur in the regular way, and one or two periods may then pass with only a threat of its occurrence. Parents must not be alarmed at such irregular occurrences. Nor are they to take, as is too often done, any steps to force the discharge, such as administering drastic purges and other kinds of medicine. The general health of the girl remaining good, no alarm need be entertained, and in any case no haphazard methods should be resorted to. (Refer to p. 483.) One thing it is desirable to notice here. The external passage (vagina) is almost closed in the virgin by a membrane called the **hymen**, which stretches across it near its entrance. Through a narrow opening in its centre, or through several smaller openings, the discharge from the womb escapes externally. In rare cases no opening exists, and the discharge does not escape but is pent up within. The girl may, at the usual time for the appearance of the discharge, have the symptoms that have been noted, but there is no flow; and thus one period after another may pass, the discharge accumulating behind the barrier. The accumulated discharge will in time form a swelling, even though it gives rise to no other symptoms, and there will be the appearance of a tumour in the abdomen enlarging with each returning period. This, taken with the absence of any discharge externally, has more than once given occasion for most unjust suspicion. In such a case as this the point to note is that on no occasion has the discharge ever appeared. If any discharge had at any period appeared, it would have proved that the way was open.

Once the discharge has been fully established it should return at the regular periods during the whole of the child-bearing epoch. It is, however, interrupted by pregnancy, and does not, as a general rule, occur during suckling. Its disappearance under any other circumstances is to be regarded as a disturbance of health, which will probably be attended by other symptoms also. The **duration of each illness** varies in different persons. According to one authority the most

common length of time is eight days, then three, and then four. The quantity of discharge during one period it is also impossible to state with definiteness. From 2 to 6 ounces may be stated as extremes which are within the limit of health. Any larger quantity should lead one to seek competent advice. While four weeks is the usual time that elapses from the beginning of one illness to the beginning of the next, there are variations quite consistent with health. One woman may "alter" every three weeks, and another only every six weeks. All departures from what is stated to be the general rule are to be judged by the custom of each person and by the condition of her general health.

The discharge comes mainly from the inner surface of the womb, and while it lasts the womb is in the condition of having a greatly increased blood supply, and of being in consequence fuller and heavier than during the interval between two periods. These changes in the womb, as already noted, are coincident with similar conditions in the ovary, attending the ripening and discharge of an ovum. In the virgin condition the ovum passing down the fallopian tube into the womb undergoes no change except that of breaking down and becoming dissolved.

The Change of Life.—At the age of forty-five or thereby, earlier or later in different individuals, the regular periodical illnesses begin to cease. They rarely cease at once, but become irregular. The "illness" returns at irregular intervals, and gradually the discharge diminishes in amount. It also greatly varies, being at one time scanty and at another very profuse, till it finally ceases. The womb at this time becomes smaller in size, and the ovaries shrivel rapidly. At this time the woman is in an unstable condition of health, and liable to many minor ailments, and also to some more serious. She is liable to headache, flushings of the face, and disturbances of the digestive and nervous systems. When this period is safely past, however, a time of good health may be looked forward to with some confidence.

Vicarious Menstruation.—This is the term which has been applied to a discharge of blood coming periodically from some part of the body other than the womb, and taking the place of that discharge, which is absent or very scanty. Instances of such menstruation are not very common. But there have been cases in which bleeding from the lungs, stomach, nose, &c., occurred at the usual period, and seemed to be the means of relieving the system when the ordinary discharge was wanting or scanty.

The Management of the Monthly Illness.—Details of the nature of the monthly illness have been given above, in so far as they seemed advisable for the purpose of communicating some intelligent appreciation of the character of occurrences of which every woman's body is the seat. It is but in accordance with reason and common-sense that a woman should have some degree of accurate knowledge of so important a function. Disturbances of this function are surprisingly common, are, indeed, apparently becoming more and more common, many of the conditions of modern life directly disposing to them. That they are the cause of much suffering, borne largely in silence, because of the natural modesty of women and dislike to seek advice on so delicate a subject, is known to every medical practitioner of even limited experience. Ignorance is undoubtedly mischievous, and a certain amount of knowledge on the part of every woman desirable. Nowadays the only question is how, when, and by whom ought the necessary information to be imparted to every girl. Every medical man recognizes that a little knowledge of the subject would enable women to avoid much of the misery and suffering they incur by their ignorance. For this purpose the above details have been given as plainly and simply as seemed to suit the circumstances of the case, and for the same purpose the following general directions as to the management of the "illness" are given.

It is because the occurrence of the monthly illness is natural and periodic that women, so familiar do they become with the process, pay little heed to its indications, and do not much take it into consideration in regulating their habits of life. In arranging for their work or their pleasure too little account is taken of it, though every woman knows pretty accurately the time of its return. Even when some disturbance arises connected with it, less attention is paid than would be to disorder of the same extent of any other function. All this is the very reverse of what ought to be. For, at the very outset, it must be remembered that at the period of the illness the whole system is in a highly-strung condition, extremely sensitive to every variety of influence; the nervous system, in particular, is peculiarly impressionable, and the person, therefore, more open than at any other time to disorder of various kinds. It would only, on this account, be in accordance with

reason and common-sense that special care should be taken while the illness lasts, and for a brief period both before it and after it, to maintain good bodily health, and to guard against everything likely to affect it. Thus common-sense would suggest that exposure to cold, to damp, to draughts, and such like should be avoided. Thus during the period mere jumping out of a warm bed and placing the bare feet on a cold floor or wax-cloth has often been the cause of serious illness. Wet clothing and wet feet are specially hurtful. If women would not permit the familiarity of the process to make them forgetful, it would not be necessary to insist on these obvious precautions. It requires very little thought, moreover, to make one perceive that, at a time when so much bodily energy is directed to one function, and when so great a drain on the system is present, less, considerably less, than the usual amount of exertion ought to be undertaken. Indeed, during the days that the illness lasts, much more rest than is customary ought to be indulged in, no work requiring any strain should be undertaken, fatigue should be carefully avoided, the ordinary duties should be lightened, and some rest and quiet taken during the day. This is not always possible; but every endeavour ought to be made, even when the usual day's duties must be performed, to make them as light as possible, and to undertake no exertion that can be avoided. If this is so with even necessary duties, it is excessive foolishness for a woman to expose herself to undue excitement during the period, specially the excitement of a round of pleasure or gaiety. Social gatherings, dances, games implying physical exertion, such as lawn-tennis, boating, riding or walking excursions—all these should be refrained from at such a time. Those who are in charge of houses ought not to leave the illness out of account in arranging their domestic concerns. The dreaded "spring cleaning" and the inevitable "washing day" ought to give way when necessary, and mistresses ought not to forget that some days of apparently slovenly and half-hearted work may have a reason other than than that of idleness or carelessness, and ought when needful to lighten the burden of work to their servants accordingly. Those who have the care of young girls, whether their own daughters or not, do not fulfil their duty to them unless they exercise supervision over them sufficient to prevent them by their ignorance incurring needless risks.

Warm clothing is particularly needed during the period. Of the kind of clothing enough has already been said, but the desirability of some flannel clothing may again be urged.

As regards food not much special direction ought to be required. In the sections on Food full explanations are entered into regarding the quantity and quality of foods necessary for the maintenance of vigorous bodily health, and the relation of these to work is discussed. But it is plain that when special demands are made on the system, as they are at each recurring menstrual period, special care needs to be taken that a due quantity of nourishment is supplied. At such a time any deficiency in quantity of food or any error in kind will become most evident and most hurtful. Often at this period women are less inclined for food when it is most needed, and are too prone to quiet any appetite that is present with cups of tea, which, while they refresh and stimulate for the moment, supply no real nutriment. Plain, simple, easily-digested food of the ordinary kind at regular intervals is very necessary. At the same time too plentiful or too rich feeding is also injurious. Rich dishes, pastries, &c., are not to be encouraged. It is also too common to attempt to relieve the feeling of depression or exhaustion by stimulants. They cannot supply the place of appropriate nourishment, and are apt to lead to bad habits. It is always those who do not take fit nourishment that are most prone to turn to stimulants, and it is always they who are most injuriously affected by alcohol, since it quickens the waste going on in the body without affording any material to supply it. As a general rule the use of stimulants is to be condemned. The circumstances that make them useful are considered in discussing scanty and excessive menstruation in the latter part of this section.

The question of exercise for girls is as important as for boys, and is discussed elsewhere. It is only necessary to say here that, during an illness, as much rest should be taken as possible, and for a day or two after the period also. Active exercise during that time is the greatest possible mistake.

Bathing is to be avoided during the illness, and in particular cold bathing.

PREGNANCY AND ITS MANAGEMENT.

Conception.—Every four weeks, as has been stated, in the adult woman an ovum becomes ripe and is discharged from the ovary. It is caught by the extremity of the fallopian tube and passed down the tube towards the womb. If the changes arising from conception do not

occur, the ovum breaks down and disappears. If, however, shortly before it leaves the ovary, or during its descent of the fallopian tube, the ovum is met by the male element, which enters into it and fertilizes it, a set of changes occurs in it which lead to the formation of a new being. The material supplied by the male consists of a thick whitish fluid, in which the microscope reveals curious bodies, represented in Fig. 186, formed of an oval part, called the head, which is about the $\frac{1}{8000}$ of an inch long, and of a tail, the $\frac{1}{400}$ of an inch in length. They are called **spermatozoa**, and they are the essential element supplied by the male for conception. The fluid having been introduced into the female in the act of sexual intercourse, the spermatozoa find their way upwards into the womb and on to the fallopian tube, partly by the lashing movements of the tail, and if in their course they meet an ovum, still in fit condition, one or more spermatozoa entering it produce conception. Among the earliest changes that thereafter occur in the ovum is one by which, from the original single cell, a mass of cells is produced. Fig. 187 shows at 4 ova, magnified. Soon after the entrance of the spermatozoa the

Fig. 186.—Spermatozoa, the male element in conception.

Fig. 187.—First changes in the Ovum after conception.
1, 2, and 3 are enormously magnified; 4, less so.

ovum divides into two (1 of fig.); each of these two then subdivides into two, making four (2 of fig.); each of the four subdivides, so that eight are formed, and the process goes on to sixteen, thirty-two, sixty-four, &c., until a mulberry-shaped mass of cells (3) is formed, all derived from the original single cell or ovum. This process is supposed to occupy about eight days, and to occur while yet the ovum is descending the fallopian tube, and about the end of that time it reaches the womb, which has meanwhile been prepared for its reception, and where it is detained till the new being is more fully formed. It is from the mass of cells thus produced that the body of the child is gradually developed.

While conception is more likely to result from connection shortly before or within a few days after an "illness," there is really no period at which intercourse may be had and conception not be possible.

The Growth of the Offspring.—When the ovum which has been fertilized by the action of the male element reaches the womb it is not much larger than its original size, about the $\frac{1}{120}$ of an inch. It becomes attached to the walls of the womb in a peculiar way. Before its arrival changes take place in the inner lining membrane of the womb, causing that lining to become much increased in thickness, and owing to the increased thickness the surface is thrown into ridges and furrows. The small ovum apparently is detained in the womb by falling into one of these depressions, and becoming buried, as it were, by the ridges of the thickened wall growing round and over it. About the third or fourth week after conception the ovum has become completely imbedded in the wall, in which it forms a little swelling. Meanwhile by this time the surface of the ovum is not smooth and regular as it originally was, but is

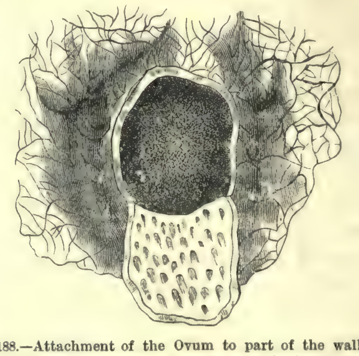


Fig. 188.—Attachment of the Ovum to part of the wall of the Womb. Part of the membranes covering over the front of the ovum has been turned down.

covered by a set of shaggy projections, termed **villi**. These villi are the result of changes going on rapidly within the ovum. They become imbedded in the substance of the wall of the

womb, which completely surrounds the ovum, and thus an intimate connection is effected between the body of the mother and the growing offspring. At this period the condition of things is represented in Fig. 188, where the ovum with the shaggy projections of its own lining membrane is shown resting on the wall of the womb, which has grown up around it so as completely to surround and cover it. The ovum is thus shut up in a little chamber in the wall of the womb, and is shut off from the cavity of that organ.

In the early period of its formation the new being is called an **embryo**, and in the later period before birth it is called a **fœtus**.

It is evident from Fig. 188 that as the embryo grows the swelling in the wall of the womb will grow larger and larger, and will gradually encroach on the space belonging to the cavity of the womb, until at length, with increased growth, the part of the wall which covers over the embryo will bulge right across to the opposite side, will, in fact, come into contact all round with the rest of the wall of the womb, and will become merged into it. This happens after the second month of pregnancy. The shaggy projections, that have been mentioned as growing out from the wall of the ovum, undergo increased growth at that part of the ovum opposite to the part of the womb on which it rests, and at that place blood-vessels come to occupy their interior. At other parts of the ovum they shrink and disappear.

Formation of Membranes and After-birth.—That part of the wall of the womb on which the ovum rests undergoes special development, and as the result of the special growth on the part of both the womb and ovum at that place, a special structure is formed, called the **placenta**, by which the structures of the embryo and those of the mother come into intimate relationship, and in which the blood belonging to each comes into such close contact that exchanges of material can take place between them. It is by means of the placenta that the nourishment of the growing offspring is obtained, it being a bond of union between offspring and mother, the agent through which nourishment is conveyed from the blood of the mother to the child. The placenta is also called the **after-birth**, from the fact that after the birth of the child it is separated and expelled from the womb. By the end of pregnancy it forms a disc-like mass, measuring 7½ inches across, ¾ inch thick, and about 20 ounces in weight. Connected with it near the middle is the **umbilical cord**, by means of which the growing embryo is attached to the placenta. Running within the cord are two arteries which carry the blood *from* the embryo to the placenta. In the placenta the blood is distributed in large spaces, and comes into close communication with the blood of the mother, by means of which its purity and nourishing qualities are maintained. From the placenta the blood passes back along the cord in a vein to the embryo, to which it gives up the requisite supply of material for continued life and growth.

To return to the ovum. We have seen that after conception it divides into two cells, then into four, and so on, till a mass of cells is produced, which dispose themselves in such a way that a hollow sphere is formed. It is from the outer layer of this sphere that the shaggy projections are thrown out which become connected with the part of the wall of the womb that has covered over the ovum, forming an outer membrane. On a part of the sphere the embryo begins to develop, and as it grows the parts of the sphere beyond the place where it is developing rise up round it, and finally meet and close over it. Thus the embryo comes to be inclosed within a membranous sac of its own, called the **amnion**, while it maintains its connection with the parts beyond by a cord, the umbilical cord. As the embryo grows, fluid is formed within the sac, and thus the embryo as early as the second month is floating in fluid contained within a sac, and connected with the wall of the mother's womb by means of a cord and the placenta. With further accumulation of fluid the amnion enlarges till it comes into contact with the outer membrane already mentioned, with which it becomes fused. So in the later stages of pregnancy the fœtus is freely movable in a mass of liquid contained within a large sac formed of the blended membranes, and is suspended in the liquid by the cord, the other end of which is attached to the placenta, which is in close connection with the wall of the womb, the womb itself being completely filled by the sac and its contents. In the course of labour the membranes are ruptured and the liquid escapes, in common talk "the waters break."

Progress of Growth at different months.—In the course of the third month of pregnancy the ovum, with its growing embryo inclosed within its membranes and floating in the fluid, comes to occupy the whole cavity of the womb. As the embryo continues growing the womb must needs enlarge with it.

After the end of the third month of preg-

nancy the growing offspring is now called a fœtus, and is so called till birth takes place. At this time the fœtus measures from 5 to 6 inches in length, and weighs about 4 ounces. Already at this time the sex is distinct, the outline of the body is complete, the eyes and ears are formed, and the nails have commenced to form.

At the end of the fourth month the fœtus has increased to 7 inches in length and nearly 9 ounces in weight. A slight down, instead of hair, begins to appear on the scalp and surface of the body, and brisk movements occur, though they may not yet be felt by the mother.

With the end of the fifth month the length has increased to from 8 to 10 inches and the weight from 10 to 12 ounces. Early in the fifth month the first movement is usually detected by the mother, and this is called the period of quickening, though, as has already been said, this is only the time when the mother feels the movement, which has previously occurred unperceived by her.

At six months the growing child is 11 to 12½ inches long and weighs more than a pound. The nails are solid, and eyebrows and eyelashes have begun to form.

In the course of the seventh month the length increases to from 12½ to 14 inches, and the weight is considerably increased by deposit of fat under the skin. In the male child the testicles begin to descend from the cavity of the belly towards their proper position.

By the end of the eighth month the length of the child is usually about 17 inches, and the weight 4 to 5½ pounds. The skin is red and covered with down. In the male child one testicle has completely descended, usually that of the left side.

At birth the average length is from 19 to 24 inches, and the average weight 7 pounds.

Male children are usually larger than female children. While 7 pounds is an average weight there are many variations. 5½ to 6 pounds weight means a very small child, and 12 to 13 a very large child, but such extremes are now and again met with.

The Duration of Human Pregnancy.— The average duration of pregnancy is between 274 and 280 days, or about forty weeks. It is roughly counted as nine calendar months. This period should be estimated from the time of conception to the time of birth. But the time of conception, that is, the time when the male element meets the ovum and enters into it, it is impossible to learn, for the period of conception is not necessarily the same as the period of sexual intercourse. The ovum may be fertilized even before it has left the ovary, or in any part of its course down the fallopian tube before reaching the womb. Conception may not take place thus for several days after intercourse, or it may take place shortly after intercourse, according to the distance the spermatic fluid has to travel before reaching the ovum. The time is, therefore, dated from the end of the last monthly illness, and the usual course is to count 280 days from the last day of the last illness. Conception is believed usually to occur about a week after the end of the last illness; the duration of pregnancy is counted as nine calendar months, so that the time of confinement as likely to occur nine months and one week from the last day of the last illness, that is about 280 days. This supplies a ready method of counting. From the last day of the last illness reckon nine months forwards, and add seven days. Thus, a woman ceased to be ill on the 7th January; nine months forwards gives the 7th October, and adding seven days, we have the 14th October, as the probable date of delivery. A shorter method is to count three months back instead of nine months forwards, and then add the seven days. Thus three months back from 7th January is, of course, 7th October, and seven days gives 14th October as before. As another example, suppose the 10th February to be the last day of the last illness, three months backwards gives the 10th November, and adding seven days we get November 17th as the probable date of confinement.

This method of counting is based on the fact that, as a general rule, the monthly illness ceases during pregnancy. But the ovum that becomes fertilized may not be the one whose ripening was at the time of the last monthly illness, but it may be the ovum of the succeeding month whose maturing was not attended by the monthly discharge, because conception had occurred. That is to say, conception may have occurred either within a few days after the last illness, or immediately before the succeeding illness was due. This gives a difference of three weeks. If, then, one has accurately known the last day of the last monthly illness, and has properly counted 280 days (or nine months and seven days) from that time, and if the confinement does not occur within a week after the estimated date, it may be expected not to take place for an additional fortnight, that is altogether three weeks after the originally fixed date.

While 280 days have been mentioned as the ordinary duration of human pregnancy, there is good reason for believing that very considerable variation in the length of time may occur, and yet the pregnancy be a perfectly natural one. Cases are on record where the only possible conclusion was that pregnancy had extended to 295 days. In Scotch law and according to the French Code the utmost limit is 300 days.

Signs of Pregnancy.—It may at the very outset be observed that up to the fourth month it is not possible to obtain any certain sign of pregnancy. Indeed, it may be said that the eighteenth week is about the earliest time when any really reliable evidence can be procured. It is possible for experienced persons to be deceived even long past that period, and women who have already borne children are occasionally themselves under the delusion that they are with child up to a time very close on that at which confinement would be expected. At the same time there are signs present very early in the course of pregnancy that, in ordinary cases, are accepted as sufficiently conclusive, which, however, ought not to be taken as satisfactory evidence against a woman protesting against such a conclusion. These early signs are:

stoppage of the monthly illness,
morning sickness, and
changes in the breasts.

Stoppage of the monthly illness (*cessation of menstruation*) is usually the first sign of pregnancy, for as a general rule throughout pregnancy there is no discharge whatever. There is, however, a number of cases in which the monthly illness does not cease immediately after conception, but goes on for a month or two thereafter, creating some doubt in the woman's mind as to the period of conception. In a smaller number of cases the illness occurs, almost as usual, up to even the fifth or sixth month, and in much fewer cases seems to occur regularly throughout the pregnancy. Some doubt may be occasioned in such cases, as has been already said. It is, however, much more important to remember that the monthly illness may cease for many reasons totally unconnected with pregnancy. It is quite common for the illness to become very irregular, to recur at long intervals, or to cease altogether for many months in young persons, as an effect of a depressed general system, or of some disturbance of health totally unconnected with the generative organs. Various disorders of the generative organs also cause interruption of the periodic illness for long periods. While, therefore, cessation of the illness in a married woman will quite properly lead one to suspect the occurrence of pregnancy and to seek for further evidence, it would be grossly improper on account of this alone to suspect anything of the kind in the unmarried. Unfortunately this has too often been done most unjustly and with most unhappy results. Such a sign as this must not be interpreted by itself. For instance it has happened that while, as regards the womb itself the illness has occurred, the discharge has not found an outlet owing to some obstruction of the passages. The discharge has been pent up within the cavity of the womb; and this has gone on month after month, the material accumulating within the womb and producing enlargement, and when it has gone on long enough the appearance of swelling of the abdomen. Such swelling, taken with no appearance of monthly illness, has seemed conclusive evidence of pregnancy, with grievous results to innocent persons. By itself then this suppression of monthly illness is not to be held as offering any sufficient evidence one way or another.

Morning sickness is another common occurrence early in pregnancy, but like the former it is not constant, nor yet is it reliable. It is specially in the morning and early part of the day that the sickness is felt, hence the phrase "morning sickness," and it wears off as the day advances. The feeling of sickness is generally accompanied by vomiting. It is commonest in the first months of pregnancy, beginning about the fourth or fifth week, and often disappears after the womb begins to rise up into the cavity of the belly, that is in the course of the fourth month; but it occasionally lasts through the whole nine months, producing much distress and great exhaustion. After the few early months it may disappear to return during the last months, owing probably to local irritation of the stomach caused by the proximity of the much-enlarged womb. Many mothers hardly suffer from it at all. Others are not afflicted with sickness, but with other kinds of digestive trouble, heartburn specially, water-brash, flatulence, acid indigestion, and so on. Different persons are affected in this respect in different ways, and even as regards the same person the course of one pregnancy may be very different from that of another. One curious form of digestive disturbance is the aversion that may arise for certain foods formerly enjoyed, and

the craving for others of an unwholesome, and in some cases, even loathsome character.

Changes in the breasts begin in the early weeks, and are at first feelings of fulness and tenderness, and sometimes even of sharp pain. The breasts feel firmer to the touch also, and the veins of the skin over them are more marked. About the ninth week the nipple is more erect and prominent from the greater supply of blood. Around the nipple is a dark circle, called the areola. After the ninth week the colour of this areola deepens, and the areola itself becomes larger; the little elevated points present in the ordinary condition of the breast become more prominent and marked. These appearances are always much more pronounced in dark than in fair women. In dark women also about the fifth month an outer circle of faint colour may be perceived, called the secondary areola, which has been described as presenting the appearance produced on a dingy white, or tinted surface, by drops of water falling on it, and taking out the colour. The deepening of colour is due to the deposit of an additional quantity of pigment in the deep layer of the skin, and since the deposit is more or less permanent the change is most marked in first pregnancies. Increased darkness of colour also occurs in a line about a quarter of an inch broad along the middle line of the belly from the navel downwards. In some women also patches of a yellowish-brown colour appear on the forehead, cheeks, breast and neck, which, however, disappear shortly after the birth of the child.

These signs, then, of suppression of the monthly discharge, morning sickness, and similar digestive disturbances, and changes occurring in the breasts are the earliest indications of the pregnant state. Not one of them, however, taken alone is to be regarded as offering satisfactory proof of that condition, but all taken together, while not affording conclusive proof, are to be regarded as very strong presumption of such an occurrence.

Among the later signs of pregnancy are—

enlargement of the abdomen,
movements of the child—quickening, and
detection of the sounds of the child's heart.

Enlargement of the abdomen does not occur till towards the fourth month, when the womb begins to rise upwards from the cavity of the pelvis (p. 22) into the abdomen. In the earlier weeks the increased weight of the womb, due to its added contents, causes it to sink more deeply in the pelvis, and this produces in the second month rather a flattening of the surface of the belly. By the fourth month the womb requiring increased room has risen upwards, and may be detected above the edge of the bony ridge in front. By that time the person will be conscious of an increasing tightness of the dress, and by the end of that month the hollow round the navel is less marked than usual. A progressive increase in size occurs till at the seventh month the hollow has disappeared, and the navel is on a level with the rest of the skin, after which time it begins to extend beyond the general surface. But, as with the other signs, this one must not be considered alone, for a tumour in the belly, dropsy connected with the ovaries, discharges pent up within the womb, as already noted (p. 487), and other causes will produce enlargement, which only skilled persons can distinguish from one another. Nor yet can this sign be taken along with that of suppression of the monthly illness as conclusive evidence of pregnancy, because monthly discharges prevented from escaping will occasion both conditions.

Movements of the Child—Quickening.—A mother first becomes conscious of the movements of the child in the womb at a period, roughly stated, about the middle of pregnancy. More accurately it is from the sixteenth or seventeenth week of pregnancy onwards that the movements may be detected, and if the date be noted it affords valuable aid in determining the probable time of delivery. The period at which these movements are felt is called the **period of quickening**, because it was thought that then for the first time the child became active. In reality it is active before this, but about this time the enlarging womb comes into contact with the belly walls, and so the movement becomes sensible to the mother. The sensations are actually due to movements of the child, kicks, movements of the knees, &c., and are at first felt as feeble flutterings, which, as pregnancy advances, become more and more pronounced, till they may even occasion pain and cause the mother to cry out. By the fifth month they may be excited by pressing with the hands from the outside on the belly walls. In later stages the movement is easily visible, and one may be able to feel with the hand the outline of a knee, &c., as it passes along the wall of the womb. Now this is one of the most convincing signs of pregnancy; but it is yet possible to be in error regarding it. Rapid movements of gas in the intestine, irregular contractions of the muscles of the belly wall, heaving movements due to a bulging of the wall of a large artery (aneurism),

&c., may be mistaken for movements of a child, and have been so mistaken by women who had previously borne children. Moreover cases of what have been called "phantom tumour" have occurred, in which enlargement of the belly and the sensation of jerking movements were due to spasmodic contractions of the muscles of the walls of the belly.

The detection of the sounds of the child's heart is a sign which affords unmistakable evidence of pregnancy. The beating of the child's heart may be detected about the eighteenth week of pregnancy. It is found by placing the ear on the belly at a part midway between the navel and the bony part at the bottom of the belly and a little either to the left or right. Instead of applying the ear directly the stethoscope is commonly used. The beat is distinguished from the pulse of the mother by its rapidity. It generally ranges from 130 to 160 per minute, and is more rapid in female than in male children. The position mentioned is the one in which the sound is heard, because at this stage of pregnancy the child is usually placed head downwards, with its back forwards and to the left or right, usually to the left. Some portion of its back is thus brought into contact with the front wall of the womb, and as the womb is in contact with the belly wall the sound is conducted. The child may, however, be lying in some unusual position, so that the sound is not conducted to the place mentioned, and it may be difficult to find any part of the belly wall at which it is heard. While, therefore, the detection of the sound is conclusive evidence of the presence of a child and of its life, the non-detection must not be taken as conclusive evidence of there being no pregnancy or of the death of the child. It will, therefore, be understood that this is a sign requiring to be sought for by a skilled person.

There are other signs a physician would endeavour to find to confirm his view of the presence or absence of pregnancy, but it is needless to detail them here.

On the whole, then, it will be evident that it is not always an easy matter to settle definitely whether a person be pregnant or not. The absence of the monthly illness, the occurrence of morning sickness, of changes in the breasts, and of enlargement of the belly may lead one to entertain a strong positive opinion, and yet that opinion may be mistaken. If, however, a competent person detects with certainty the beating of the child's heart, continued doubt is not possible. This cannot, however, be detected much before the fifth month. The necessity for caution in coming to any conclusion, particularly in certain circumstances, cannot, therefore, be too strongly insisted on.

The Management of Pregnancy.—The months of pregnancy are periods of considerable anxiety and trouble to most women, and are especially so to those who pass through them for the first time. It is natural that women, pregnant for the first time, should seek advice and counsel from more experienced female friends, who are as a rule too willing to offer the results of their experience, and to impress their lessons on the mind of their less experienced friend. As a rule, however, the advice is as various as it is plentiful, and often very conflicting. It is, moreover, so often accompanied and enforced by narrations of misfortune and trouble that the mind of the receiver is often perplexed and confused, but also filled with grave fears, which she can hardly utter. Now it must not be forgotten that pregnancy is a natural process, that nature is usually sufficiently able to accomplish well her purposes, and that the vast majority of pregnancies if allowed to pursue, without meddlesome interference, their natural course end naturally, easily, and successfully. The woman, who is looking forward with some quite natural anxiety to the birth of her child, should turn a deaf ear to the tales of woe, which friends too often delight to communicate, and should endeavour to preserve a cheerful and equable frame of mind, which is the only condition justified by the facts. She ought early in the months of her pregnancy to determine who shall be her medical attendant, and if she has any doubts or misgivings, or really wishes advice on any particular point, she ought without hesitation to go to him for it. If she has made even an ordinarily good choice, she will find her doubts removed, and her mind quieted, and will have an authority, to whom the advice of her friends can be submitted, and by whom it can be, without offence to them, satisfactorily disposed of.

Much may be done by pursuing a regular method of living to make the months pass in comparative ease and comfort. To aid in accomplishing this some general directions will be given.

Food.—There is no special diet suited more than another to the pregnant state. The rule is plain nourishing food at appropriate and regular intervals. Very rich and highly-seasoned dishes are undesirable. In some cases there is

a craving for certain articles, and provided they belong to the nourishing class of foods, the yielding to the craving in moderation is not to be denied; but in a few cases the craving is for unwholesome and nauseous substances. This is to be considered as morbid, and ought to be held in restraint not only by the person herself, but also by all who surround her. Stimulants are neither necessary nor desirable in ordinary circumstances. It is not denied that they are often useful and perhaps also necessary, but the usefulness and necessity ought to be judged of by the medical attendant and not by the patient herself or her friends.

In the later months a bandage, broad in front and narrow behind, if properly fitted so as to support the womb without compressing it, will give much comfort. It should be put on while the person lies in bed on her back, and should be removed at night.

Clothing should be carefully adapted to the varying condition of the person, and should never be at any part tight fitting. Enough has already been said on the subject of corsets (p. 473), but in the pregnant condition their evils are much increased. "The Romans were so well aware of the mischief caused by compression of the waist during *gestation*, that they enacted a positive law against it; and Lycurgus, with the same view, is said to have ordained a law compelling pregnant women to wear very wide and loose clothing."

Exercise.—During the early months of pregnancy there is difficulty in taking walking exercise, because the womb sinks down lower than usual on account of its increased weight, and makes walking attended with discomfort if not actual pain. When the womb has risen upwards, owing to its requiring more space, this difficulty becomes less, and thus during the middle months of the nine, exercise is more pleasant and less fatiguing. Towards the end of pregnancy it becomes increasingly difficult because of the size and weight, and also because the joints become more lax in preparation for the period of delivery. Gentle, regular, and moderate exercise, obtained by walking, should, however, be persisted in throughout the whole period, never, however, so as to cause pain. The patient must not allow her inclination to be completely at rest so to overcome her as to prevent her obtaining the slight change and beneficial stimulus, which a short period in the open air will secure to her. In particular the desire to avoid the public gaze ought not to keep the person completely indoors for the last month or two of pregnancy as it too often practically does. Gentle carriage exercise need not be forbidden, but jolting over rough roads is plainly likely to be injurious. Lengthened shopping expeditions and such like are too frequently the cause of miscarriage during the early months as well as during the later months. While more rest is needed than in the non-pregnant state, an increased amount of rest ought not to be permitted to lead on to idle, lazy, and indolent habits.

Bathing.—Baths should be taken in moderation, extremes of heat and cold being carefully avoided.

The Breasts require some attention. Pain, swelling, and tenderness of the breasts are among the early signs of pregnancy, as we have seen, and require no special attention. But if the breasts are small and ill-developed, and the nipples pressed in as they may be by the pressure of stays, trouble after delivery may be saved by drawing them out with the aid of a breast-pump, or the ordinary breast-exhauster (Plate VIII.). Should the nipples be tender the best means of toughening them is by the use of the tannin and glycerine of the chemists. The use of alum and whisky is too apt to make them hard with a tendency to crack.

Medicine.—It is a matter of the greatest moment, for the comfort of the patient, that daily movement of the bowels be obtained. This ought if possible to be secured by diet—the use of oatmeal, fruits like figs, prunes, stewed apples, &c. Sometimes medicine is needed, and many take a dose of castor-oil at regular intervals. It is comparatively safe, though nauseous, but it often occasions "false pains" near the termination of the pregnancy. The writer is in the habit of recommending not castor-oil but Hunyadi Janos mineral water. If there is any doubt at all of obtaining daily an easy and sufficient movement of the bowels, he advises the mineral water to be taken each morning before breakfast, in the quantity the patient finds suits her, and it ought to secure a gentle motion without purging after the lapse of an hour or two. The average quantity is a claret glassful, but the patient should begin with a small wine-glassful and go up, if necessary, till the suitable quantity is found. It should be then regularly taken. It is a simple remedy, practically incapable of doing harm, and its use he has found, over and over again, to conduce greatly to the health and comfort of the patient. No other medicines should be employed without proper advice.

LABOUR AND ITS MANAGEMENT.

The Stages of Natural Labour.—Natural labour is the process by which the child is expelled from the womb and born into the world. It occurs at the end of the ninth calendar month of pregnancy, or, as has been already mentioned, about 280 days after conception. It probably begins at the time when a monthly illness would have been due, counting such illness as recurring every twenty-eight days, that is to say, at the time when the tenth monthly illness from the time of conception would have become due. As we have seen, the womb is composed largely of muscle. As pregnancy advances it becomes greatly enlarged to make room for the growing child. Its walls also become greatly increased in thickness, and the muscular fibres become increased not only in number but also in size. The chief force in labour is the contraction of these muscular fibres. The fibres are so arranged in the walls that when they contract and shorten they tend to diminish the size of the womb and of its cavity, and thus act in the direction of squeezing out of the womb its contents. The walls are so strong that when they contract in this way they exert a very great force, and are thus able to overcome very great resistance to the expulsion of whatever the womb contains. The amount of resistance will depend on the bulk of the contents—on the size of the child—and on the width of the passage through which the child has to pass before reaching the outside. The first resistance, however, occurs at the mouth of the womb, which is closed or at least not much wider than to admit the passage of anything thicker than an adult's finger. The child can, therefore, make little advance along the passage till the mouth of the womb has been sufficiently dilated or stretched, and this opening up or dilatation of the mouth of the womb is, accordingly, the first thing to be accomplished in the labour process. It forms **the first stage of labour**.

It has been already mentioned (p. 485) that the child is inclosed in a bag of membranes, floating in a liquid (the waters), having a cord attached at the navel by which it is connected with a mass called the placenta or afterbirth (p. 485) attached to the inner wall of the womb, by means of which union with the mother is maintained. By the contraction of the muscular walls the bag of membranes, with its contents of waters and child, is pressed on and forced in the direction of least resistance, that is, against the mouth of the womb. The mouth being slightly open the membranes and their contained fluid bulge into the slight opening and are a very active agent in widening it. Sometimes the mouth of the womb is rather rigid and the force pressing the membranes into it is so great that the pressure of the fluid bursts them, and a gush of water takes place—"the waters are broken," as the phrase is. The part of the child's body that is directed downwards—usually the head—is then pressed directly against the mouth of the womb, but it being larger and not able to insinuate itself into the small opening as the bulging membranes did, dilates it much more slowly, and the labour is all the more tedious. During the first stage of labour, then, it is desirable that the membranes should remain unruptured and that the "waters" should not escape.

It is the contractions of the muscular walls of the womb that occasion the pain characteristic of labour. They are not continuous, but last only a brief period, so that there are periods of pain followed by periods of freedom from it. The intervals of rest prevent exhaustion of the muscular walls and also of the mother, and at the same time permit the mouth of the womb to be gradually and gently opened up without risk of injury, while the child also is allowed an interval to recover from the compression which, in the later stage of labour, each contraction exerts on it. The pains during this first stage are of a cutting or grinding character, and are usually trying to the mother, because she feels as if no progress were being made by them. She is often, on this account, irritable and restless under them, frequently changing her position and uttering complaints. A considerable interval elapses between each pain in this stage, perhaps twenty or thirty minutes at first, but the interval gradually lessens as the opening up of the womb becomes more nearly sufficient, till towards the end of this stage they may be returning every five minutes or oftener. The pain is usually felt more in front. While this stage lasts efforts of straining or pressing downwards do not render any assistance in opening up the mouth of the womb, and they ought not to be encouraged, since they throw away the patient's strength, which ought rather to be reserved for the second stage, when they are of great value. It is of advantage, however, for the patient to move about her room, and interest herself in some gentle occupation during the intervals of rest, rather than confine herself to bed.

The second stage of labour begins when the mouth of the womb is sufficiently widened to permit each contraction of the womb—each pain—to urge the child through the opening and down the passage to the outside, and it ends with the birth of the child. During this stage the bag of fluid is no longer a help, but rather a hinderance, and, therefore, it is proper for the attendant to introduce a finger into the passage, and when a pain occurs to press the point against the bulging and stretched part so as to burst through it. This permits the escape of the water and allows the advancing part of the child to come directly into contact with the walls of the passage, which it is best able to stretch. The upper and inner end of the passage is formed of the bony rim of the pelvis and is practically unyielding, so that the child in advancing through it must have its body compressed and moulded to permit of its passage. Were the pains constant the continued compression might be injurious to the child, and so the intervals of rest, though brief, are beneficial. The remainder of the canal is formed of soft and yielding structures, which the advancing part of the child stretches with more or less ease. But here again the periods of contraction, followed by intervals of rest, permit the parts to be stretched to some extent and then to be released from pressure. Thus the widening of the passage is accomplished gradually and without risk of injury.

During the second stage the patient naturally fixes her body, bends the knees up towards the body and the head towards the chest, grasps something fixed with the hands, and holding her breath presses down. The pressure thus exerted by the walls of the belly greatly aids the process of delivery. During this period, therefore, the patient remains in bed, and the more quietly she lies, the more firmly she holds her breath, while the pain lasts, and the more vigorously she presses down, the more speedy will be the termination of her suffering. In a few cases, when the child is advancing with great rapidity, and the parts are being stretched too quickly and forcibly for safety, one does not permit the patient to have anything to grasp, and, instead of urging her to hold her breath and press down, one asks her to cry out, to refrain as much as possible from pressing down, and thereby to prevent the pressure by the walls of the belly. The pains during the second stage are felt at the back, and the patient is much aided by some one pressing the back firmly with the palm of one or both hands. Towards the termination the mother feels something pressing low down, and the bulging and opening out of the external parts indicate the near approach of delivery. The advancing part of the child appears at the external opening, which it widens as the pain occurs. With the interval of rest it retreats. When another pain occurs it advances further, stretches the opening still more, and with another interval again retreats. The child may seem just about to be born, when the pain ceases for a minute or two, and it goes back again. This sometimes disheartens a mother somewhat, but it is desirable, for it permits the gradual widening of the opening, and diminishes the risk of tearing. Finally, with a great effort the first part of the child is born, the rest of its body quickly follows, and the delivery of the child is accomplished.

The third stage of labour, however, remains. It consists in the expulsion of the after-birth, with which the cord passing from the child's navel is connected, and it is usually unaccompanied by much pain, and occurs within from five to thirty minutes of the birth of the child. It is often expelled from the womb when the child is born, and lies in the passage for a little time, till it is removed by gentle pulling on the cord by the attendant, or ejected by contractions of the walls of the passage itself.

The after-birth is separated from the wall of the womb by its contractions. But with its separation blood-vessels of the mother are opened and a raw surface is left. From this for an instant blood escapes, in considerable quantity, but is speedily checked by the contraction of the womb, which now becomes permanent, squeezing the mouths of the bleeding vessels together and thus closing them. Some blood remains in the cavity of the womb, which is reduced by the contraction to very small dimensions. It gradually oozes away as discharge. Any clots that remain do not escape so readily, and excite small contractions to get rid of them. These are the occasion of the **after-pains**. So that the more thoroughly the womb is emptied of all clots after the separation of the after-birth, the fewer will be the after-pains; and they will be severe and troublesome for a day or two if any quantity of clots has remained behind. Usually after-pains are absent in a first labour.

The Duration of Labour varies naturally with the size of the child and the width and capacity of the canal through which it must

pass, as well as with the age, vigour, and build of the patient. It is longer in first labours than in those subsequent, on an average twice the length. The average for first labours is roughly twelve hours, and for others six. The first stage occupies generally two-thirds of the whole time. At the same time it is not possible to gauge what is likely to be the time occupied during the later stages from that occupied by the first. For a labour which has begun quickly and gone on quickly for some time may become much slower as its termination approaches, or the reverse may occur.

The Position of the Child in Labour.—In the womb even in the early months of pregnancy the child usually bends forwards, and in the later months the head is bent forwards upon the chest, and the thighs bent upwards to the belly, the knees and elbows also, and the arms crossed and folded over the breast. This is called the **attitude of the child**, and it suits best the cavity in which it is placed.

It is usually the head that is directed downwards towards the mouth of the womb. At full time this is the rule in 96 per cent of cases. But other parts of the child may present themselves first at the mouth of the womb, and the word **presentation** is used in referring to the part of the child that thus offers itself first at the opening of the womb. Thus there are head presentations as already mentioned occurring in 96 out of every 100 cases. The other extremity of the oval which the child forms in the womb may, however, be first, and thus there are said to be breech presentations, in which the buttocks present first. This occurs once in every 45 births. The child may be across the mouth of the womb—a cross or transverse presentation—and so a shoulder or hand, &c., descends first. These are happily rare, for they are very unfavourable.

Usually the head descends first, with the face directed backwards and to the right side, and when it has advanced a considerable way it turns slightly so as to make the face look directly backwards, and directed thus the child is born, the back of the head passing outwards and upwards in front of the mother, the face sweeping round the back wall of the passage. When the head has been born the face turns upwards towards the mother's right thigh, and this movement allows the shoulders to descend in the direction of the canal in which there is greatest room. As soon as they have been born, one in advance of the other, the birth of the rest is easy. In its descent along the canal the child's head is moulded more or less in proportion to the difficulty of the labour, so that when born it has a peculiar elongated appearance, which gradually passes off in the course of a few days.

The Management of Labour.—Labour is a natural process, and in the vast majority of cases is best accomplished by nature's own unaided efforts, without any necessity of meddlesome interference. It is only now and again that interference is necessary or desirable. As, however, in nearly every case where interference is necessary, there is a particular period when it may be more easily and successfully employed than at another, a woman in labour ought to have from the beginning the services of a skilled attendant. If on examination he finds everything going on properly and naturally, it is a great comfort and encouragement to the patient to be told so, and if, on the other hand, he finds something that requires active interference, he can choose the best time for it, and is ready for the emergency. It cannot, however, be too strongly stated that the cases where interference is really necessary are not so common as is supposed, are indeed rare in proportion to the natural and unaided births.

The woman should be in a quiet airy room, with a fire burning in the grate, and with all proper conveniences at hand. Her companions should be few, and cheerful. Of all the plagues of a lying-in room that woman is the worst, who beguiles the hours of waiting by relating her experiences, and recalling all the horrors and misfortunes of which she has heard as attending the termination of pregnancy.

The bed should be prepared in the usual way. On the top of the under sheet is then placed a square of waterproof, in the place over which the patient's hips will be as she lies in bed; above the waterproof is a blanket folded into a square of sufficient size. Or the blanket may be folded so as to be of greater length than breadth, and is so placed that as one part gets soiled it may be drawn forwards from below the patient and a fresh portion thus brought under her. It is well also to have a square of waterproof *below* the under sheet. On a screen before the fire is hung, ready folded, another blanket to replace the soiled one when it is withdrawn, and also a sheet similarly folded. In the first stage of labour it is well to allow the woman to be up, and moving about or occupying herself between the intervals of pain. When the second

stage comes on, she should get into bed, lying on the left side with the knees drawn up and fixed by means of the feet pressing against a stool or such contrivance, while the upper part of the body is fixed by the patient tightly grasping a towel fastened to something at the head of the bed. The strong downward pressure the woman can thus exert is of great value in the second stage, though it is only a waste of strength in the first. The patient should have on the clean clothing she means to wear during her confinement to bed, but it should all be well gathered up above the waist out of the way of discharges, and lightly fastened round the waist should be a petticoat which will protect the clothing to some extent, and be easily slipped off over the feet, when the labour is over.

At the commencement of labour, if the bowels have not been properly moved for some time before, it is well to clear them out by means of an enema injection.

During the labour drink, cold water, &c., is not to be refused, but, of course, ought to be partaken of only in moderate quantities. A warm cup of tea may be refreshing, but stimulants are to be given only by medical orders, and without such advice no drugs should be taken with the idea of terminating the confinement more quickly.

Just when the child is being born the patient should refrain as much as possible from severe pressing down, that the risk of tearing the parts may be diminished. It appears also that the common custom of placing the hand over the external parts to hold against the advancing head is more likely to lead to rupture than to prevent it.

In anticipation of the birth of the child, its clothing should be hanging before the fire, a bath, warm water, a clean sponge, and some good soap should be in readiness, also a pair of scissors, and two pieces of linen thread, each piece about a yard long, and twice doubled with a good knot at each end, for the purpose of tying the cord. Some olive-oil should also be at hand. As soon as the head is born the attendant should pass the fingers up to feel whether the cord is round the neck. If it be, the finger should be able easily to slip it over the shoulder. One hand is then placed over the outside of the belly, and grasping the womb, as it were, gentle pressure is to be made following it downwards as it descends. The body of the child will usually be born within a few seconds of the head without any further aid, though gentle pulling may be made with one hand on each side of the head, if aid seems needed from threatened suffocation of the child or other cause. Rarely the membranes are not ruptured during labour, and the child is born still inclosed in them. They must in such a case be quickly torn, else the child will be suffocated. The child is said in such circumstances to be born with a "caul." This, of old, was considered a sign of good omen, and seamen used to seek to obtain the caul under the belief that it protected the wearer from death by drowning.

The Treatment of the Newly-born Child.—As soon as the child is born it should be placed in a position in which it may breathe easily, bedclothes being kept off its face, &c., and mucus wiped from the mouth and nostrils with a clean napkin. Usually the mere contact of its naked body with the air causes a gasping movement followed by regular breathing and lusty crying. If this does not at once occur, it is ordinarily readily induced by suddenly blowing in the child's face, smartly patting it on the buttocks, rapidly rubbing the fingers up and down the sides of the chest, or dashing a small quantity of cold water on the chest. All these means, by irritating the nerves of the skin, stimulate the movements of breathing. In the meantime it is proper not to tie the cord or separate the child from its attachment to the mother. For if the fingers be placed on the cord pulsation will often still be felt, indicating that the circulation in the after-birth has not yet ceased, and there is thus the possibility that the child's blood may still be aerated to some extent through the mother. If the pulsation has stopped, and the child's breathing is not yet established, the cord should be tied, and then divided, and the child's body should be quickly plunged into a basin of warm water, the head of course being supported, and then as quickly removed from it, and cold water plentifully dashed over the chest, then plunged again into the hot water and again the cold dashed over it, till by the sudden changes the breathing is established. If these methods do not speedily produce the desired effect, artificial respiration must be resorted to. The little finger (quite clean) of the attendant should be introduced into the mouth and passed to the back of the throat to sweep out any mucus there. Then one of two methods may be adopted. Dr. Howard, of New York, advises that the child be supported on the attendant's left hand and

arm (as shown in Fig. 189), while the right hand grasps the lower part of the chest. The chest is steadily compressed for three seconds, and then suddenly let go. After waiting for

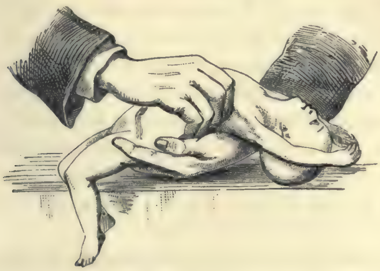


Fig. 189.—Howard's Method of causing breathing in the newly born.

three seconds the pressure is repeated, and so on, ten to twelve times a minute. The second method consists in the attendant, after cleaning the child's mouth, applying his or her own mouth closely to it, and the child's nostrils being closed, gently and steadily blowing till the chest is seen to be inflated. On allowing the nostrils to open the chest will fall again; they should be again closed, and the blowing repeated. This should be continued for a considerable time, at the rate of ten to fifteen times a minute, and if any effort to breathe be made by the child itself the blowing should be timed to aid it.

In ordinary circumstances little effort is needed to excite breathing beyond the slapping, &c., already noted. All that remains to be done, then, is to tie and cut the cord. This is done in the following way. Two pieces of linen thread folded twice, each with a large knot at both ends, are used. One piece is tied tightly round the cord about 1½ inches from the belly, and the other piece an inch further away. The cord is then divided *between the two pieces of thread.* Care must be taken that, in the act of tying, the cord is not suddenly jerked, lest it be torn from its attachment to the belly, which would occasion bleeding very difficult to stop. Further, while the cord is being divided, care must be taken lest the child by a sudden twist brings fingers, toes, or other part between the scissors. As soon as the child is separated from the mother, it is handed over to be washed. This process should be done quickly with warm water, a clean sponge and *a little* good soap. Every part of the body, but especially wherever there are folds of the skin, must be carefully washed, then thoroughly dried, and afterwards *lightly* dusted. Sometimes parts of the body are covered with a white material which soap and water will not remove. Let the nurse rub such parts with oil, lard, or butter till a kind of lather is produced, and then washing will readily remove it.

After the washing the stump of the cord must be dressed. A square piece of linen is employed, the stump is passed through a hole cut in the middle, and the linen is then folded over from above and below, and from each side. It is then *lightly not tightly* secured by the binder. The clothing suitable for the child is given in detail on p. 444, and its feeding on p. 438. It must receive no sugar and water, nor any food except the breast milk.

The Treatment of the Mother after the birth of the child. The first thing requiring attention after the removal of the child is the removal of the after-birth. If the hand has been pressing down on the womb from the outside during the birth of the child, this will probably have aided the separation of the after-birth. The hand is to be again applied on the belly over the womb, which ought to be felt as a firm roundish mass, and if the womb be grasped and gently but firmly pressed downwards and backwards, a slight rubbing movement being at the same time practised, the womb will usually be found to grow smaller and firmer, and to descend. The hand must follow it, the firm pressure being continued, when the after-birth will be readily expelled. *The after-birth is not to be removed by pulling on the cord,* only a gentle pull is to be exerted on it, if the womb is contracted, and merely to aid its expulsion, not forcibly to draw it out. When it appears at the external opening it is to be taken into the grasp of the hand and twisted round and round a considerable number of times. This coils the membranes, expelled with it, into a sort of rope, and prevents any part of them being retained in the womb, to give rise to severe after-pains. After the removal of the after-birth, the hand should be kept pressing on the womb for a little time, and if it show signs of relaxing to any extent by growing larger and rising up into the belly again, slight rubbing will cause renewed contraction, and in a short time it will remain firmly contracted.

The petticoat or other garment which has been round the woman's hips must now be slipped over the legs and pulled out along with the soiled blanket, &c., from under the patient, who meanwhile remains lying on her back, exerting herself as little as possible. A folded and warmed napkin is placed between the legs

to absorb the discharge, the clean warm blanket within a folded sheet is pushed under her, and a bandage applied round the waist. The bandage should be shaped to fit her body and should be fastened with safety-pins in front, a pad of a couple of folded napkins being placed beneath it and over the womb. The bandage is to be fastened with a moderate degree of tightness, and adds much to the person's comfort. The clothing and bed-clothes are now adjusted and the patient left to rest, the head being low.

Soon after the mother has been made comfortable she may have a warm drink, cup of warm tea or such simple drink, *but no stimulant.* It is well as soon as the child is dressed to put it to the breast, if the mother is not too tired, for a few minutes. The contact of the child's mouth with the breast gently stimulates the contraction of the womb, and tends to prevent relaxation of the womb and bleeding. Regularly every third hour thereafter the child must be replaced at the breast (see p. 438), whether there be milk or not. The effort at sucking promotes the production of milk.

If the mother be thirsty a small quantity of cold water or milk is not to be denied her, but only a small quantity is to be allowed. After the first application of the child the woman needs a rest. The infant should be removed to its own basket-bed, in order to permit a two or three hours sleep to its mother. When she awakes she needs food. The old practice was to give only tea and dry toast for several days after confinement, and to deny rigorously all cold drinks. This is absurd, and fortunately is only now practised by the ignorant. The mother needs good nourishing food. It should be provided her in small quantities at regular intervals of three or four hours. It may consist of boiled bread and milk, varied with beef-tea, mutton soup to which only rice and parsley have been added, about a breakfast-cupful at a time with bread, and once or twice in the twenty-four hours a cup of tea and lightly-buttered toast, if such be desired. Diet such as this, if given in moderate quantities at the three or four hours interval, will suit admirably for the first two or three days. During the night the food is also to be supplied. By the third day a soft-boiled egg, switched, and given with bread and milk, will be acceptable, or boiled white-fish, with the cup of tea, beef-tea and soup being also given as before. By the fourth day or thereby the diet may be varied with some well-cooked minced meat or a lean broiled steak or chop, with bread, and piece of chicken and so forth. Thus gradually the diet will return to what is usual, more detailed directions for which are given on pp. 439, 440. Thirst is relieved by small quantities of cold water or milk, soda-water and milk, &c.

If by the third morning after the birth the bowels have not been moved, a sufficient dose of castor-oil should be given. Thereafter, if medicine is required a wine-glassful of Hunyadi Janos mineral water given in the morning is best. Any difficulty in passing water will be relieved by the application of flannel, wrung out of hot water, over the lower part of the belly and between the legs.

Throughout this time the mother remains in bed, not being allowed to sit up for any purpose, food being given by means of a drinking-cup, and the discharges being passed into a bed-pan. *Visitors are forbidden.*

Sitting up in bed is not to be allowed till the seventh day, and then only for a brief period for meals, and the patient must not be allowed out of bed at all before the tenth day, and then only for a few minutes, wrapped in blankets. A fortnight after the birth is soon enough to permit the mother to get up for any length of time with clothes on. Even by that time she should rise for say an hour in the forenoon and an hour in the evening, and each day gradually lengthen the time till after another week she spends the better portion of the afternoon out of bed. It is infinitely better for her to take a long period of rest in order to rise thoroughly recovered and with restored strength, than to get up too soon and require to take soon to bed again with full recovery impeded. Details as to the management of the period of nursing are given on pp. 438 to 448.

After-pains are of the nature of labour pains on a small scale, and are due to irregular contractions of the womb, owing to the presence of blood clots and the effort to expel them. As a rule they do not occur after a first labour, and may be greatly lessened after subsequent labours by the method of following the descent of the womb with the hand, and by the method of removing the after-birth, which have been described. They may be relieved by the application, close up between the legs, of a thick pad of flannel wrung tightly out of hot water. If they are severe a single dose of twenty drops of laudanum may be given. This is to be repeated in two or three hours, only if really necessary.

The discharge from the womb for the first

twenty-four hours after labour is of blood, and contains sometimes small clots. It gradually becomes less red, and by the third or fifth day assumes a greenish or yellowish hue. It has a peculiar odour. It gradually becomes colourless, and finally ceases by the end of two or three weeks. For the first few days the discharge is to be promoted by occasional gentle bathing of the external parts with warm water. Strict cleanliness must be observed, and clean napkins freely employed.

DISEASES OF WOMEN.

AFFECTIONS OF THE GENERATIVE ORGANS.

Diseases of the External Parts.

Eruptions, &c.—The skin in the neighbourhood of the external opening of the genital canal is liable to many of the affections common to the skin in other parts, and such affections may affect the membrane lining the entrance to the passage.

Thrush, for example, such as occurs in white patches in the mouths of children, is not infrequent. Refer to page 460. The treatment described there is to be adopted.

Herpes (p. 317) is also found. It soon disappears if kept smeared with vaseline or zinc ointment, and if cleanliness be exercised.

Inflammatory Blush (p. 313), due to irritating discharges or the rubbing of opposed surface, is to be treated by bathing with warm water, then drying carefully, and dusting with oxide of zinc powder.

Erysipelas is to be treated as advised on p. 314.

Eczema (p. 318) is usually due to irritating discharges, to dribbling of urine, and is frequently the result of diabetes (p. 303). It occurs in very fat women, who perspire freely and are not sufficiently given to frequent bathing. It may spread from the inner surface of the passage outwards over the skin, down the thighs, and up over the belly, and round to the opening of the bowel. The surface is red and leaking, crusts form owing to the drying of the discharges, and bleeding cracks are produced. The parts are extremely sore and smarting, and painfully itching. The intolerable itching causes frequent scratching, which tears the tender surface, causing it to bleed. The main part of the treatment is scrupulous cleanliness. The parts should be bathed several times a day with warm water, and some mild soap—glycerine or tar soap. Any discharge from the passage, or any other apparent cause, must, of course, be got rid of. Bathing with warm lime-water, or warm water to which a pinch of carbonate of (baking) soda is added, relieves the itching. An ointment may then be used made of oleate of zinc (60 grains) and vaseline (2 ounces), or oleate of bismuth (60 grains) and vaseline (1 ounce), or chrisma sulphur. In the absence of these the ordinary oxide of zinc ointment, made with vaseline instead of lard, will do; or a wash made of glycerine (1 ounce), borax (60 grains), and rose-water (1 ounce). Should such measures fail the person must consult a doctor, lest diabetes be at the root of the trouble, or some irritating condition of the urine.

Warts, of a soft kind usually, are found just at the opening of the passage or just within. Sometimes they exist in great numbers. They may be removed by the use of glacial acetic acid, very carefully applied. The top of the wart alone is touched, and the application is repeated daily till it disappears. The patient herself should not attempt to apply it, as she will certainly be unable to prevent the acid running on to sound skin. Besides this, the part should be frequently bathed, dried and dusted. Any discharge should be treated.

Growths, called **tubercles**, much larger than warts, also occur. They require skilled treatment.

Sensitive Red Patches are occasionally found just within the entrance of the passage. They may be associated with small, red, sensitive growths round the opening of the urinary passage. They occur about the time of the change of life; they occasion much distress, and are very difficult of treatment. It is almost useless to mention treatment here, but any irritating discharge should be removed, if possible, and strict cleanliness should be observed. Some dry cotton wool inserted just within the passage will make walking more easy, and at bed-time a plug of wool, soaked in a solution made of equal parts of glycerine and neutral acetate of lead, will relieve pain. Any of the sensitive growths referred to require the aid of a surgeon for their removal.

Itching of the Genitals (*Pruritus*).—This is often a most distressing complaint. The itching is intense, accompanied by burning heat and tingling. It is commonest in women advanced in life, though it also occurs in the young. The itching is usually aggravated by warmth,

and thus the suffering is most intense shortly after the person gets warm in bed.

It is not necessarily accompanied by an eruption, though it is the companion and effect of such a disease as eczema, referred to on the preceding page; but it may exist, to begin with, without any eruption or any appearance of change in the skin whatever. But as a result of the scratching, from which the patient cannot refrain, though it is painful, cracks, scratches, &c., are produced, which bleed, and with the continual scratching may become themselves painful, and lead to the formation of scabs, crusts, &c. This, however, is not the cause but the result of the itching, in this particular instance.

Treatment.—Such itching as has been described is not to be regarded as a disease in itself. It is to be looked on rather as a sign of disease, and its true cause must be searched for and found, if it is to be satisfactorily treated.

A common cause is diabetes (p. 303). The writer has seen several cases of this most annoying itching in elderly women, for which no washes or local applications afforded more than a temporary relief, and which had existed more or less for months, and in one case a couple of years, the cause of which showed itself at once on an examination of the urine, and which disappeared very soon after diabetic treatment (p. 303) was resorted to.

The presence of a constant irritation is another frequent cause. The irritation may, however, be of many varied kinds. It may arise from a discharge of whites or other discharge from the womb or genital passage, or the watery discharge of cancer; it may be due to some condition of the urine, excessive acidity, the presence of oxalates (p. 302), stone in the bladder, or worms in the bowel, or, and this is not to be overlooked, it may be the result of the work of the particular kind of louse found in this region (p. 325).

A variety of other conditions may occasion it,—a gouty or rheumatic state of body, various unhealthy states of the womb, &c. &c. Besides all these, it would appear sometimes to be due simply to a condition of over-sensitiveness of nerves of the part.

Each cause has its own appropriate method of treatment, and it will usually require the skill and patience of an educated medical man to determine what that cause is, and what the proper treatment ought to be. Without such advice, the patient should try the effect of frequent bathing, and syringing with tepid water, to which a pinch of common baking soda may be added, the parts being dried after the bathing, and then lightly dusted with white oxide of zinc powder. A lotion made of 60 grains of the acetate of lead to 2 ounces of water is very soothing, or a lotion of 1 grain of bichloride of mercury to 1 ounce of water may be tried. The latter is very poisonous, and the bottle containing it should be carefully labelled and kept out of the way, lest accidents happen from mistaking it for something else.

Inflammation round the external opening is called *Vulvitis*. It is not seldom met with in infants and young children. Want of cleanliness may be the cause, or injury, and it is not necessary to suspect contagion from the child being ill treated, though, of course, such might be the cause. The parts are red, swollen, painful, itching, and from them flows a mattery discharge. If there is much pain and redness, soothing poultices should be applied, warm bread poultices or warm poultices of boiled mashed turnips. If the parts are not acutely inflamed bathe first with lukewarm water, and then with a lotion made of 20 grains of sulphate of zinc to 10 ounces of water. A gentle purgative of calcined magnesia or effervescing citrated magnesia is useful, and good nourishing food must be given.

Boils and Abscesses form in this region. Soothing poultices must be applied, and any matter present must be removed. This requires a surgeon. Proper advice is all the more necessary, as a rupture (**hernia**, p. 191) occurs here in female children, and must not be mistaken for an abscess.

Diseases of the Vaginal Passage.

Inflammation extending, that is, beyond the mere entrance up into the canal, is called properly *Vaginitis*.

Its **cause** may be very various—want of cleanliness, irritation of worms which have passed up the canal from the bowel, the presence of foreign bodies, such as a pessary introduced for a displaced womb, &c. Simple exposure to cold, especially at a monthly period, seems capable of producing it. It occurs, also, in the course of diseases like measles, small-pox, scarlet fever, and is more apt to be found in persons of depressed general health. Irritating injections may be its cause, and it may be the consequence of direct infection.

Symptoms.—The passage is hot and tender,

there is a sense of burning and smarting, bearing-down pain, frequent desire to make water, and pain in passing it; aching and throbbing are felt in the passage, and walking is attended with difficulty. The external parts may also be swollen and inflamed. There is also discharge, at first of clear and then of yellowish matter, which is often badly smelling. After a sharp attack the inflammation may pass off in a few days or weeks, or it may become chronic in persons whose vital powers are depressed.

Treatment.—In the period of acute inflammation the person should be kept at rest in bed; brisk saline purgatives, seidlitz-powders, or effervescing citrate of magnesia, should be given, and mild food, milk, soups, &c. *Stimulants must not be given.* Without skilled advice hot hip baths may be given, or injections of water as warm as can be comfortably borne. The injection should be given with an enema syringe (Higginson's or Davidson's, see Plate VIII.). The nozzle should be of caoutchouc, five or six inches long, and several openings should exist *round the extremity of the nozzle, not one at the very point.* The person should lie on her back, with the hips raised. The water should be injected *slowly*, and care must be taken that it escapes quite easily. From a half to one gallon of water may be used at one time, and the injection may be repeated twice or thrice daily in sharp attacks. After the injection a medicated pessary of 3 grains extract of belladonna should be pushed up into the passage and allowed to remain. It gives great relief. When the acute stage is past an injection of 30 grains sulphate of zinc to 1 pint of water is to be used. At the same time any bad state of general health requires treatment if the disease is to be got rid of.

Discharges from the passage (*Whites, Leucorrhœa*).—The lining membrane of the passage is studded with minute glands, which produce a clear thickish fluid for keeping the parts moist. Under a variety of circumstances it is so increased in amount as to appear externally as a discharge. Just as when one has cold-in-the-head, or catarrh as it is properly called, the minute glands studding the lining membrane of the nostrils pour out their discharge, which ordinarily is simply sufficient to keep the nostrils moist, and there is in consequence a "running at the nose," so, as the result of exposure to cold or damp, the genital passage may be affected with catarrh and the discharge appear. It may be thin and milky in appearance, or thick and sticky, or yellowish. Commonly it is whitish, and has, therefore, been called "the whites." Besides being the result of cold, it may occur as a symptom of depressed health, in pale delicate girls for example, as an expression of defective nourishment. It may also be a consequence of prolonged nursing. The discharge may originate, not in the passage, but in the womb itself, and may be the expression of some disorder there. In pale, weakly girls such a clear discharge may occur at the monthly periods without any discharge of blood. It will be the constant attendant of chronic inflammatory conditions of the passage.

The subject of such a chronic discharge usually complains of backache, discomfort in the lower part of the belly, and general weakness. This weakness may itself be the cause of the discharge, but the occurrence of the discharge will make the weak state of health all the worse.

Treatment ought to be directed to the cause of the disorder. In states of bad general health efforts must be made to improve the general health. For such a purpose the bowels must be regulated, preferably by such a gentle medicine as a mineral water, for example a wine-glassful of Hunyadi Janos each morning. A moderate amount of exercise should be obtained daily. Overwork of every kind is most injurious, whether in the case of the married woman who has a house and children to look after, or in that of the girl who has some business occupation in the workshop, warehouse, office, or school, or in the case of the girl going in for the higher education. Easily digested, nourishing food is essential. Change of air and sea-bathing are very valuable, and quinine and iron tonics ought to be administered. In the way of direct treatment to the parts the person should restrict herself, failing advice, to simple measures. Warm-water injections, and injections of a lotion of sulphate of zinc (2 grains of sulphate of zinc to 1 ounce of water), are useful, or injections of iron-alum of the same strength. If the discharge be irritating, an injection of a lotion containing ½ ounce of carbonate of soda (baking soda) to 1 pint of water, affords great relief. If such measures fail competent advice must be obtained. Indeed, where at all possible, such advice ought to be obtained from the commencement, as the inflammation may extend up into the womb and onwards to the ovaries, or to the bladder, and lead to very serious consequences.

Fistula implies the existence of some unusual communication between the genital passage and the lower end of the bowel on one side, or between the genital passage and the urinary bladder on the other. The former is called **recto-vaginal fistula**, and the latter **vesico-vaginal fistula.** The commonest cause of both arises in the course of labour. It may be that the rent occurs in the process of delivery, either with or without instruments, from the narrowness of the passage and the want of stretching capacity, or from the size of the child. In such cases it is commonly the partition between the genital canal and the bowel that gives way. It may result from long-delayed labour, when the head of the child becomes fixed and long-continued pressure is maintained upon some part of the walls. In such a case it is usually the division between the passage and the bladder that yields. Part of the wall has become so damaged by the pressure that some time after delivery, a day or two or a week or two, it separates and comes away as a slough, leaving an opening, through which the urine from the bladder finds its way into the passage. While the former misfortune may occur even with the most careful and skilled management, the latter is commonly the result of mismanagement, undue delay having been allowed to occur in the use of instruments or other means of hastening delivery. The same unusual communications may be opened up by the bursting of abscesses, by prolonged ulceration, by destruction of parts owing to cancerous disease, by wounds, and so on. But there are less frequent causes than those above mentioned. In the case of the opening between the bowel and passage, matters from the bowel will be passed by the genital opening, and in the case of communication with the bladder, urine will dribble away in an unusual manner. Other results follow. The presence of discharges in the genital passage foreign to it almost certainly occasions some degree of inflammation, extending to the external parts, which become inflamed and ulcerated, and occasion much misery by their constant smarting and itching.

Treatment of such conditions have become much more hopeful in recent years, due mainly to the skill of American surgeons Emmet and Marion Sims. The treatment consists in an operation for reuniting the edges of the tear. It is, of course, in cases where the rent is comparatively simple, as in those arising during childbirth, that the treatment is likely to be adopted, and not in fistulæ the result of cancerous ulceration.

Tumours and Growths of various kinds may occur in connection with the external parts of the genital organs or in connection with the genital passage. An **abscess** may form on one side of the external opening large enough to block the opening, and may appear to the unskilled as a solid growth instead of a mere collection of matter. Such might occur as a result of inflammation, or from some slight blow or bruise, or even from such a slight cause as the tearing out of a hair. In a similar situation there occurs, though rarely, a swelling due to a **rupture** (*hernia*, see p. 191), a loop of bowel passing down from the abdomen into a position similar to that which it occupies in the male. To mistake this for an abscess would be very serious indeed. It can be reduced and prevented from returning by the use of a properly fitting truss.

Cancer occasionally occurs on the external parts, in the form of skin cancer (see p. 434). Within the passage itself cancer does not often occur, unless it extend inwards from the outside, or downwards from the womb. When it is present, pain, bleeding, and a foul discharge are among its usual signs, but nothing is conclusive apart from the opinion of a competent medical man, who has made a thorough examination.

All sorts of **foreign bodies** have been found in the passage, which have been passed in accidentally or by design. It is not uncommon for a doctor to have to remove a pessary, inserted for treatment of displaced womb, which has remained there for years, forgotten by the patient, and has become almost fixed in the parts, in the end producing inflammation, discharge, &c. The removal of such bodies should be attempted only by skilled hands.

Diseases of the Womb.

Inflammation of the womb is a very wide term, embracing a variety of diseases known to medical men under special names, and requiring special treatment. It will be sufficient here to indicate the general features which the various forms of the disease have pretty much in common, and the general lines of treatment which can be safely adopted when medical aid is not readily obtainable. If reference be made to page 479 the distinction will be understood between the body of the womb and the neck

of the womb, which latter ends at the mouth, opening into the genital passage. Inflammation, then, may attack both the body and neck of the womb, or it may limit itself to one or other. Further, the womb is largely composed of muscle, but, within, it is lined with a mucous membrane, containing glands buried in it and opening on the surface (inner). The inflammation may exist mainly in the muscular walls, or it may be limited to the inner lining membrane. Thus there may be inflammation of the muscular walls of the *body* of the womb, or inflammation of the lining membrane *of the body* of the womb, and there may be inflammation of the muscular walls of the *neck* of the womb, or inflammation of the lining membrane of the *neck* of the womb.

Here are, then, four varieties of inflammation. Moreover, in each of these four cases the inflammation may be acute or chronic, and so there may be eight forms of inflammation of the womb. The symptoms, while presenting similar general features, will vary somewhat with each separate condition, and the treatment, to be thorough, ought also to vary somewhat to suit the particular case. The extreme advisability, therefore, of any one suffering from any of the symptoms of disorder of the womb, consulting a skilled medical man, ought to be sufficiently plain.

Happily the inflammation of the muscular walls, whether of body or neck of the womb, may be dismissed with the remark that they are comparatively rare. The common form, and it is, in its chronic form, extremely common, is inflammation of the lining membrane *of the neck* of the womb, and to that attention shall be confined, note being taken in the course of its description of any symptom indicating that the inflammation has spread upwards to the lining membrane *of the body* of the womb.

Symptoms.—The common symptoms of inflammation of the lining membrane of the neck of the womb, when not of an acute form, are profuse discharge of whites, some amount of pain in the small of the back, worse with standing or walking and increased at the monthly periods, and a sense of indifferent general health. If the disorder has lasted for a considerable time the patient will of necessity suffer from general debility to a greater or less extent, and will be paler than is consistent with health. Her digestion is almost certainly disturbed, and she may suffer from depression or nervousness, and a variety of pains and aches, now in one part of the body and now in another. The bowels are probably confined, and the urine is dark and thick. The discharge that appears externally may be glairy and clear, like white of egg before being boiled, or may be white or yellowish matter.

If the attack be acute there are pain and tenderness in the parts, throbbing with a feeling of bearing down, irritation of the bladder and frequent desire to pass water, and the discharge is often tinged with blood and of an offensive smell.

It is to be noted, however, that inflammation may exist for some time without pain, or any other symptom, except that of a profuse discharge of "whites."

Causes of the disease are numerous. Exposure to damp and cold, especially in those of feeble health, insufficiently nourished, and who fail to obtain sufficient exercise and fresh air, the irritation of a displaced womb, or instruments introduced into the passage to restore a displaced womb to its proper condition, the frequent use of irritating injections, and various other causes may produce it. It is excessively common in married women who have borne children, and too prolonged nursing may with them excite its occurrence. Nor must excessive intercourse and direct infection be omitted in the list of causes.

The condition of the parts is very much that of an inflamed and swollen throat. The lining membrane is swollen and congested, and the discharge proceeds from the glands which exist in it in enormous numbers, just as from a swollen and inflamed throat there proceeds excessive "defluxion."

The inflammation of the lining membrane of the body of the womb is attended by discharge similar to the other, but in greater amount, and disturbances of the monthly illness—irregularity, excess, or diminution—are more common. Marked nervous symptoms are often produced by it. The person is fretful and despondent, may suffer from frequent headache, limited to the top of the head, and from other pains resembling neuralgia, and the dragging pain in the back is very marked. But any difference in symptoms is rather one of degree than of kind.

A not uncommon cause of this condition is sudden stoppage of the monthly flow from cold and the irritation of matters retained in the womb after confinement or miscarriage.

Treatment.—What has been said about the causes of this disease is sufficient to show that there can be no rough-and-ready or "rule-of-

thumb" procedure in dealing with it. If the condition be mainly caused by a bad state of general health, it cannot be supposed that applications to the affected parts will cure it while the general bad health remains. Even though such a cause has not been at work in its production, the disease cannot have lasted any time without inducing some degree of bad health, which will stand in the way of a cure. Then if a displacement of the womb is the cause of the inflammatory process, nothing short of restoring the organ to its proper position can be expected to promote a permanent recovery. A mother who suckles her child beyond the necessary period, and suffers from some disorder of the womb, cannot expect to cure by injections what is maintained by the drain upon her system of prolonged nursing. So with other causes. Now, it would be the business of a medical man, well acquainted with such conditions, to determine the cause at work in each particular case, and to apply his treatment accordingly. It is plain, therefore, that it is really quite impossible to state any definite plan of treatment which a patient might herself adopt with good prospect of recovery from her trouble. The best advice that could be given would be to place herself under the care of a physician from whom she might confidently hope to receive skilful and conscientious treatment. At the same time it is only right to state some simple means of treatment which a patient may herself adopt, when skilled advice may be for the time beyond her reach,—some means which cannot be hurtful no matter what may be the exact cause of the disorder, and which will give some relief in most cases, and in some may be sufficient for a cure.

The first thing, then, to be done is to restore, if possible, a good measure of general health. The means to that end are, good food of sufficient quantity and easily digested, the regulation of the bowels, avoidance of overwork and excitement of any kind, a fair amount of exercise, exercise short of fatigue, and plenty of fresh air—sea-air is specially beneficial. Concerning food the mistake must not be made of living on slops, corn-flour, arrow-root, and foods of that kind mainly. Milk should bulk largely in the diet, but also other animal foods, soups, eggs, fish, and a fair daily supply of butcher meat. A great many women make a grievous mistake in avoiding as much as possible such animal foods, and half-starving themselves on sloppy diet. For the regulation of the bowels nothing is better than a wine-glassful or thereby of the Hunyadi Janos mineral water taken the first thing in the morning. Over and above this some quinine and iron tonic will be of much value in depressed states of health.

As regards applications to the affected parts one thing can be very strongly advised, namely, the use of hot water injections. To obtain the full benefit they must be given in the way to be described. The patient lies across the bed, a pillow under the back to raise the hips, the feet resting on chairs. A piece of mackintosh cloth is placed under her, and arranged to cause water to flow off into a pan at the side of the bed. The injection is given by some one assisting her. About one gallon of hot water should be used, water comfortably warm to the hand, by the thermometer about 110° Fahrenheit. An enema syringe is employed, with a nozzle of vulcanite or similar material, about 6 inches long. The end of this tube should not have a single opening at its point. It should end in a blunt form, and several openings should exist round it. The syringe being properly filled and in good working order, the nozzle is oiled and passed into the passage gently near the back wall and directed backwards. It should be passed in as far as it can easily slip, and then the water should be steadily and slowly injected. Owing to the hips being raised the passage will become filled with the hot water before any flows out, and this is what is desired by the method. At the same time care must be taken that there is no obstacle to the free escape of the water as soon as it has filled the passage. The injection should be given in this way at bed-time, every night or every second night. A little patience will render it comparatively easy, and the patient will speedily discover the ease and comfort it affords. If there is any insuperable difficulty in giving it in this way, the patient must content herself by using the enema syringe while she sits over a pan or bath, but the water should be used at the same heat and with the enema, the nozzle being passed well in. If the patient is very anxious to try some medicated injection, any of those mentioned on p. 499 may be employed, after the hot water, but their use is not to be persisted in for long periods if they fail soon to give relief.

Ulceration of the Womb is a phrase that strikes terror to the ears of most women. It used to be far too commonly employed, and is probably still. The condition which it is frequently used to signify is practically that already described. Owing to chronic swelling the

inner wall of the neck of the womb and its mouth become thickened, prominent, and too freely supplied with blood, but in the vast majority of cases to which the name is given there is no such eating away of the substance of the part as the name would imply.

The **treatment**, so far as the patient can resort to it, is such as has been described under inflammation. One other thing she may be able to do, and that is, take a little ball of cotton or lint, soak it in glycerine, and then push it up the passage as far as possible. *She must be careful to remove it next day or within two days*, and after syringing with warm water may replace it by a fresh one. If it is difficult of removal syringing will readily bring it down. A medical man would employ further treatment by directly painting the affected part with one or other of a variety of applications.

Tumours of the Womb.—Three forms of tumour of the womb are of comparatively frequent occurrence, namely, **polypus, fibroid** or **fibrous tumour**, and **cancer**. There is one broad distinction between the two former of these and the latter, and that is, that the two former are simple tumours, formed of overgrowth of some part of the substance of the womb, not destroying the substance and not necessarily dangerous to life; while the latter is a growth foreign to the true substance of the part, invading and destroying it, and tending inevitably to death within a comparatively limited period.

The **polypus** varies in size from that of a small pea upwards, and may be an overgrowth of the lining mucous membrane, or an overgrowth of the wall beneath the lining membrane. It projects into the cavity of the womb, being connected to its walls by a longer or shorter stalk. By its presence a polypus causes a greater determination of blood than is proper to the womb, and thus gives rise to bleeding, especially to excessive loss at the monthly periods. It also excites contractions of the womb, and so occasions painful spasms and pains in the back and loins. It may block the opening of the womb, and by causing difficulty of escape of the monthly discharge cause the illness to be attended by severe pain.

The **treatment** is surgical, and consists in the removal of the polypus.

The **fibroid tumour**, fibrous tumour, or fibromyoma, as it is also called, may occur in various situations, and may be of a great variety of size. It is a simple overgrowth of part of the wall of the womb. It may project into the cavity of the womb like a polypus, or it may project in the direction of the outer wall towards the cavity of the belly, or it may remain embedded in the substance of the wall, difficult to distinguish from simple enlargement of the womb. In size such tumours vary from that of a pea to that of a human head. They are extremely common, but may exist without giving any indication of their presence. They rarely appear before the period when the monthly illness begins. Their growth is encouraged by the regularly recurring increase in blood supply to the womb by the monthly illness, and also by the stimulus of sexual excitement. Marriage will thus tend to stimulate the growth of one already present, while the presence of one may be a cause of sterility: the fact of sterility will also encourage the growth. As a rule they cease to grow when the child-bearing period has passed, and thus if this age is reached a woman troubled with such a tumour may look for a gradual relief from its symptoms.

The **symptoms** are of two kinds: (1) those due to the mere pressure of the growth on surrounding parts, the chief of which is pain; and (2) those due to the increased blood supply to the womb which the tumour occasions, of which the chief is excessive loss of blood during the monthly illness, or a more or less continuous loss of blood.

The pain may be of a spasmodic character due to the tumour stimulating contractions of the womb, or it may be of a neuralgic form due to pressure on nerves, or it may be a dragging pain in the back and loins, a constant wearied feeling, easily increased by walking, and also by carriage exercise when the tumour is of any size. Other pressure symptoms may exist, such as confirmed constipation from pressure on the bowel, frequent desire to make water or inability to make water, or pain in making it, swelling of the legs, &c., and such symptoms are all liable to be aggravated at the monthly period owing to the increased size of the womb at that period. Then the monthly illness may be attended with great pain owing to the tumour blocking the escape of the discharge, and the presence of the tumour also occasions not unfrequently great pain during sexual intercourse.

Excessive flow of blood may not be marked in cases where the tumour is embedded in the walls of the womb or bulging towards the cavity of the belly, but is likely to be the main symptom when it bulges towards the cavity of the

womb itself. Usually it is a prominent symptom, and, as has been said, the loss of blood may not be limited to the period of the monthly illness, but may go on almost without ceasing. The loss of blood may be so excessive as to become the grave feature of the case.

Treatment.—It is to be remembered that the tumour is a simple one, in no way to be regarded with apprehension such as a cancerous tumour would excite. It may be a constant worry and cause of suffering from pain, &c., but it need not prove fatal. The loss of blood occasioned by its presence is the serious part of it, since this may threaten life, either directly or by exhaustion, or by laying the patient open to other disease from the general bad health arising from it. The object of treatment is to relieve the symptoms as much as possible till the child-bearing period is past, when a gradual cessation of the patient's trouble is likely to ensue.

The tendency to lose blood may be restrained by avoiding everything that would increase the blood supply to the womb. As much rest as possible during the monthly illness is, therefore, desirable, and if the patient be married restraint as much as possible from the exercise of sexual functions. Pregnancy might be a serious complication, though occasionally a fibroid tumour has almost or entirely disappeared after pregnancy and a successful confinement. Unmarried women should remain so if they are aware of the existence of such a tumour. Just before the monthly illness opening medicine in the form of mineral water or effervescent citrate of magnesia is beneficial, and nourishing but unstimulating diet, with avoidance of spirituous liquors, should be the rule.

If the bleeding be excessive the effort to limit it should be made by taking the liquid extract of ergot, from one half to a whole tea-spoonful in water thrice or four times daily; and if excessive loss of blood during the period has been the rule, this should be taken for a day or two before the illness begins, and for a few days after it has ceased. To relieve pain a pill of one-third of a grain of extract of Indian hemp may be occasionally taken, or 30 grains of bromide of potassium dissolved in water. Iron tonics taken during the intervals are valuable for restoring or maintaining the general health. Pain is often also relieved by the use of some support to the uterus in the form of a pessary if such can be adjusted for the purpose.

If the loss of blood be so excessive or persistent as to threaten serious consequences, a surgeon would probably propose an operation for the removal of the ovaries. The ovaries being removed, the monthly illness ceases, and thus nature's method of relieving the patient is anticipated.

Cancer of the Womb.—This disease may occur in the body of the womb or be limited to the neck (p. 479). The former case is comparatively rare. Cancer differs from fibroid and other simple tumours, in that it destroys the substance of the organ in which it is situated, spreading through it and from it to other parts, and tending also to pass to other organs. If it be removed it is liable to return. For these reasons a cancerous tumour is called malignant as opposed to simple. The womb is the commonest seat of cancer in the female, and its occurrence there is very frequent. It rarely occurs below the age of twenty years or above that of sixty, and is most frequent between forty and fifty. It has an inevitable tendency to death, and from one to two years is the average period of life after its appearance.

Its **cause** it is impossible to state. That it has a tendency to occur in families seems undeniable, and some distinguished authorities believe it occurs chiefly in women who have borne children, and in whom the neck of the womb has been torn. Such local irritation, however, may be only the exciting cause of the appearance of a tumour to which the woman was already disposed.

There are several varieties of it. It is common as an affection of the lining surface of the neck of the womb, gradually eating into and destroying the deeper parts, occasioning ulceration and thickening extending inwards.

Its **symptoms** are mainly pain, loss of blood, and discharge. The pain may not arise till the disease is far advanced, and is of a stabbing or burning kind, shooting up to the loins and down the thighs. It is generally worse at night. It is the loss of blood that often arouses suspicion. It may occur from apparently trifling causes, and though it may be slight to begin with, it becomes at length a perpetual drain upon the body. As a consequence the person comes to have a characteristic appearance, the skin becoming of a peculiar sallow or dirty yellowish colour. The discharge is watery, tinged usually with blood, extremely irritating to the skin of the external parts, and of a very offensive smell. The disease may ulcerate its way into the bladder or bowel, so that water constantly dribbles away or motions are passed from the genital passage.

The whole system becomes affected and deranged, and if death does not occur directly from loss of blood, exhaustion is frequently the consequence.

Treatment.—If the disease be detected early enough, its removal by the knife may effect a cure, or at the least will for a season stop suffering and prolong life. Many methods of cure by medicines have been praised at different times, but all have been in the end found comparatively useless.

The foul discharge may be relieved by the injection with the enema syringe of water containing 10 grains of thymol to the ounce, or of a 2½ per cent solution of carbolic acid.

To relieve pain opium in some form is the remedy. But it should be used under medical advice.

Everything possible should be done to maintain the patient's general health by plain nourishing food, the use of iron, quinine, and similar tonics, and the regulation of the bowels by such gentle medicines as a mineral water. Stimulants should be avoided as far as possible.

Displacement and Falling *(Prolapse)* of the Womb.—Displacements of the womb are exceedingly common, commoner than is generally supposed, frequently existing without giving rise to any marked symptoms. At the same time the displacement may give rise to many and pronounced symptoms, which no treatment does anything to relieve except that of replacing, as nearly as possible, the womb in its original position.

The womb is suspended, as it were, in the middle of the pelvic cavity (p. 22) with the bladder in front of it, and the termination of the bowel behind it. It is maintained in its position by its attachment to these organs, and by bands or ligaments of its own, and in its situation is freely movable in various directions. The upper end of the body is directed upwards and forwards, and the mouth downwards and backwards, so that, when the person is in the erect position, it may be said to incline forwards.

Now it may not be maintained at its ordinary level, but sink somewhat *downwards,* for example, because of enlargement or congestion rendering it too heavy for its supports, or because the supports have become stretched and weakened. This is called **prolapse,** and will vary in degree according as the womb sinks lower and lower. If it sink greatly the mouth of the womb may appear at the external opening, and, in very extreme cases, it may appear entirely outside, which form is called **procedentia.** It naturally will drag down with it the wall of the bladder to which it is attached in front, and the wall of the bowel to which it is attached behind. Further, instead of being inclined forwards, as in the ordinary position, it may be tilted backwards, in which case the body looks backwards and the mouth forwards, and this backward tilting also varies in amount. **Retroversion** is the name applied to this displacement. Or the womb may be *bent* backwards on itself, so that the body of it is directed backwards, the mouth maintaining pretty nearly its proper position. It is doubled on itself. This is called **retroflexion.** Again the *forward* slope may be exaggerated, so that the womb tends to lie across the cavity. This is **anteversion;** or it may be *bent forwards* on itself, which is called **anteflexion.**

The **causes** of such altered positions are numerous. Congestion, overgrowth, the presence of tumours, &c., adding to the weight of the organ, tend to displace it. A very common cause of this kind arises when a woman begins to go about too soon after a confinement. The womb has not had time to return to its natural size, and its supports, stretched and weakened by the pregnancy, are unable to bear up the unusually heavy womb, and thus it assumes an improper position. General ill-health may so diminish the vigour of the supports and diminish the tone of the womb itself as to occasion a "displacement." Further, any undue pressure may force it out of place, and if this be long continued it does not get a chance of returning to its natural place. Undoubtedly a great cause of such pressure is the undue weight of clothes and tight lacing. These diminish the size of the belly cavity by pinching in the waist. The bowels are pressed upon, and to find room press downwards on the womb, &c., forcing it out of position, and *keeping it out of position.* The pressure of a tumour in the belly may act in the same way. A tumour pressing upwards from below may also displace the womb, but in a different direction. As another example, the frequent existence of a distended bowel or overfull bladder, apt to occur in women, may occasion it. Undoubtedly falls, violent exertion and such agencies are often at work in producing such disturbances of position. In women who have borne children, the womb is often deprived of its due support from below by rupture of parts during labour, and it is then apt not to be duly maintained in proper place.

It ought, also, to be noted that a womb, dis-

placed from any cause, is liable to be the seat of congestion and other disorders, because of the disturbance to the proper circulation of blood through it which the displacement occasions, and such congestion will then tend to increase the departure from the natural situation.

Symptoms.—Unless in cases of prolapse, where the mouth of the womb appears externally, there are really no symptoms, by which a patient could decide for herself the nature of her trouble. There are likely to be many which would lead her to conclude that something was wrong with the womb, but none which would enable her to conclude what was the real nature of that something. The existence of a displacement and its kind can only be determined by a skilled medical man, after he has made an examination by introducing his finger into the passage, and thus ascertaining the position of the organ.

The symptoms that point to such uterine trouble are back-ache, pains in the loin, discharge, perhaps pain at the monthly illness. A womb displaced backwards is liable to press on the bowel and cause constipation and piles; a womb displaced forwards is more apt to give rise to bladder troubles, pain in making water, frequent desire to pass water, &c. &c. There is often discomfort or difficulty in walking. Indigestion is extremely common and persistent, and is sometimes the only result of a slight displacement. Indigestion so caused is almost certain to defy any treatment directed to it, but speedily disappears if the displacement be detected and got rid of. Sterility is common in all forms of displacement, but particularly in those in which the uterus is bent on itself, for the bend blocks the canal of the womb and prevents the passage upwards of the seminal fluid. Further, nerve troubles are in many cases the main pronounced symptoms of such disorder, which, like those of digestion, defy all treatment unless the uterine condition be attended to. Such disturbances of the nervous system are more apt to occur in young unmarried girls; and the hysterical condition into which young excitable girls are sometimes brought by such a cause is not easily overcome.

The **treatment** of such conditions is in many cases not attended with much difficulty, while in other cases it is by no means easy. In all, as a general rule, very great relief can be afforded, even though a permanent cure is not obtainable. But the treatment can only be properly undertaken by a medical man. It consists in restoring the womb to its natural position, if that is possible. Sometimes it is not possible, because of the very long duration of the displacement having caused the womb to become fixed in its altered position, or because of inflammatory adhesions binding it down. It is very often possible for the surgeon to replace the womb simply with the fingers, and more often with the aid of a long slender rod, on a handle, called a sound, the use of which, in skilled hands, ought not to be attended with any considerable pain. The second element in the treatment consists in the introduction into the passage of a small instrument, called a pessary, made commonly of vulcanite, but also of celluloid, or india-rubber, in the shape of a large ring, which is so placed as to support the womb in its restored position. The shape of the pessary varies with the kind of displacement. If it is properly adjusted, it should occasion no inconvenience whatever, the patient should, indeed, be unable to perceive its presence, and it does not require any alteration in ordinary ways of life, does not, for example, necessitate a married woman living a single life, while it remains in the passage. The third element in the treatment consists in the endeavour to restore vigour and tone to the parts, so that in course of time the pessary may be removed with some hope of the womb remaining in its restored position. Such treatment necessitates attention to the bowels, to the food, to proper exercise, fresh air, &c. Tonics will aid the endeavour. But the suitable tonic depends on circumstances to be judged by the physician.

Anyone who is wearing such a pessary ought to return from time to time to her medical attendant, and ought to see him without delay if any signs of its presence irritating the passage arise. Probably the pessary will require to remain six or eight months, but it ought not to remain longer without the medical man's sanction. Patients have been known to forget altogether the presence of the instrument, and to continue wearing it for very prolonged periods, till it became fixed, impacted by incrusted remains of discharge, urinary sediment, &c.

While the instrument is being worn, frequent use of the injection by an enema ought to be persisted in. This will not only aid in restoring the vigour of the womb and neighbouring structures, but by the constant cleanliness will prevent irritation arising from the presence of the pessary. The daily use of the injection is strongly urged. The injection had better be not of warm water only, but of warm water with some added carbolic acid, of a strength

equal to one ounce of the acid to every two and a half or three pints of water. The pessary is simply to be regarded as affording a mechanical support till the womb is restored to its natural condition.

The form of displacement most readily treated by pessaries is the backward displacement, the backward tilting of the womb, and happily this is the commonest of the displacements. The forward displacement is much less easy to treat in this way, from the difficulty of adapting an instrument to this situation. Fortunately it is not nearly so common a form.

Some cases of prolapse are readily benefited by treatment on these lines, others are extremely troublesome. Recently for the most aggravated cases of prolapse, an operation has been adopted by Dr. Alexander of Liverpool, which has yielded good results. It is not a serious operation, and by it the ligaments of the womb are pulled upon and tightened, "the slack is pulled in," so to speak, and the womb thus restored to its proper height and held there. Tonic treatment is necessary to restore a good condition of general health, so that, when the instrument is removed, the womb may keep its position by its restored vigour.

Diseases of the Ovaries.

Inflammation of the Ovaries and Ovarian Pain (*Neuralgia*).—Inflammatory diseases of the ovaries are not easily separated from similar affections of neighbouring parts. Moreover, the ovaries share in disorders of the womb and in diseases of parts in their neighbourhood, the removal of which will usually be accompanied by the cure of the ovarian disorder.

Any cause tending to induce congestion of organs in the lower part of the belly will produce congestion to a greater or less extent of the ovaries and set up symptoms specially referred to them. Thus sudden stoppage of the monthly flow is such a cause, and inflammation occurring after child-birth.

The **symptoms** that point to the ovaries are pain, sometimes excessively severe, in the region of one or both ovaries, that is about the middle of the groin. The slightest pressure in this position is very painful. In chronic cases of inflammation the pain is constant and wearing, usually worse at the period of the monthly illness. In some cases it is scarcely perceived at the periods, but returns in the middle of the interval between the periods. The pain is increased by standing, walking, and by sexual intercourse. It sometimes shoots down the thigh. The monthly illness is of an unusual kind, excessive or scanty or very painful. Various nervous pains are experienced throughout the body, and a highly nervous and hysterical condition may result from the chronic form of the disease.

In some cases the pain is neuralgic in character, and the term neuralgia of the ovaries has consequently arisen.

The **treatment** depends on the cause of the affection. It can only be said here that anything likely to excite congestion of the organs in the lower part of the belly is to be avoided. Constant standing, much use of the treadle sewing-machine, of the harmonium, &c., ought to be avoided. Good food, fresh air, sea-air, and sea-bathing are valuable. Hot water injections as advised on p. 502 may be tried. The evils of the use of laudanum or other preparation of opium, and of alcohol are very great, and the inducements to their employment many. They must be strenuously avoided.

Tumours of the Ovary (*Dropsy of the Ovary*).—While there is a variety of solid tumours of the ovary, the common tumour is one containing fluid. It is a cyst or sac, of every variety of size, some weighing as much as 30, 50, or upwards of 100 pounds. Its contents may be a watery, clear, straw-coloured fluid, or a fluid more gluey and tenacious and of varying colour. While the tumour may grow slowly, it has been stated roughly that the average duration of life after its beginning is under three years. These tumours are most common between the ages of twenty and forty years.

Symptoms.—In the early stages there may be practically no symptom, and the first indication may be the enlargement of the abdomen. The enlargement may be mistaken for pregnancy, though it is usually more or less rapid than that of pregnancy; and this mistake is more apt to be made if the monthly illness ceases or becomes scanty and irregular. As the tumour grows the patient becomes thin and exhausted, and disorders of the bowels arise increasing the exhaustion.

Treatment.—There is only one form of treatment of any value, namely removal of the tumour by surgical operation. It is an operation now attended by very great success when skilfully performed, and when undertaken in time before the patient's powers are exhausted. Withdrawing a quantity of the fluid by tapping is not now so common a method of treatment as formerly. It affords only a temporary relief,

the sac filling up again in a short time, and if frequently performed it may be a serious hindrance to the operation for removal, by causing adhesions between the walls of the sac and those of the belly cavity.

DISORDERS OF THE MONTHLY ILLNESS (*Menstruation*).

Absence of the monthly illness (*Amenorrhœa*).—Strictly speaking, the term amenorrhœa, meaning want of the monthly discharge, is only applied to those cases where the monthly illness has never appeared at any time. It is, however, also applied to cases in which the monthly illness has been present, but has after a time disappeared. This latter condition is more correctly termed **suppression of menstruation.**

It is necessary to notice this distinction, for, if a girl has reached the age when the illness might be expected, and it has not appeared, it is sometimes necessary to assure one's self that the non-appearance is not due to some obstacle to the escape of the discharge externally, the illness actually occurring, but the discharge being retained.

Absence of the illness through retention.—In the virgin condition there is a membrane, called the **hymen**, which stretches across the lower end of the genital passage. The membrane is as a rule not complete, a small opening existing in the centre, through which discharges from the womb escape. But in some cases, not frequent, the membrane is complete, and thus no discharge can escape. The obstruction may exist at the mouth of the womb itself. In such cases the symptoms of the monthly illness appear without discharge. At regular intervals pains in the back and sides occur, and with each return they increase in severity. The patient has a feeling of weight, and grows pale and sallow. The retained discharge, accumulating from month to month, causes the belly to enlarge and a tumour to appear, which undergoes regular monthly increase. The girl's friends putting the absence of discharge and the enlargement of the abdomen together suspect pregnancy, and many an innocent girl has thus come under unmerited rebuke.

It is even possible for such an obstruction to occur in some part of the womb or passage after the illness had become established, and this must always be borne in mind.

This condition is remedied by surgical interference, opening a way for the retained discharge to escape. Such cases are, however, always attended with risk.

Complete absence of monthly illness may also be due to some arrest of development of the genital organs. There are thus cases in which the ovaries or womb have been absent, or present in an undeveloped condition. In absence of the ovaries the girl does not exhibit the changes in form from girlhood to womanhood. The breasts remain small and the hips narrow, the voice is manly and harsh, and the appearance becomes masculine.

Absence of the illness through suppression, that is after the illness had become more or less regular, may arise from a variety of causes. It may depend upon a condition of general health or a poor quality of blood (see ANÆMIA, p. 234). The feeble condition of general health is often the result of over-work, over-pressure at school, improper quantity or quality of food, want of fresh air, confinement in the bad atmosphere of a crowded work-room, or of some acute disease, &c. The opposite condition of too full-bloodedness may also produce suppression of the illness. Disease is another cause, and especially consumptive disease of the lungs, disease of the kidneys, and digestive and nervous disorders. Emotion, fright or grief sometimes occasion the disturbance. The illness may be suddenly arrested by cold.

The absence from failure of general health is sufficiently evidenced by the paleness of the patient. She is wanting in energy, listless and languid. These cases are readily enough separated from those due to cold or full-bloodedness.

The **treatment** is regulated by the cause. It is sufficient to state the kind of treatment needful in the variety dependent on the general health, and that due to sudden suppression owing to cold, &c. It includes good nourishing food of a plain kind, containing a fair proportion of animal food, sweet milk, eggs, fish, fowl, beef, soups, &c. The bowels must be kept regular, a saline medicine, such as seidlitz, Hunyadi Janos mineral water, or the effervescing citrated magnesia being given, if required. Especially is it necessary to insist upon abundance of life in the open air, and moderate exercise. While overwork is extremely hurtful, the absence of some bodily or mental occupation is also injurious. Change of air and sea-bathing are strongly advised, and, to those who can afford it, a visit to some of the Continental spas is recommended, especially Kissingen, in Bavaria, Kreuznach, in Rhenish Prussia, Schwalbach, in Nassau,

Spa, in Belgium, Bourboule, in France. In England Woodhall Spa, in Lincolnshire, is recommended. Much standing, stooping, or prolonged sitting, is to be avoided. As to medicines it is impossible to state what suits every case, but tonics belong to the kind required. Iron and arsenic are particularly valuable.

The following prescription may be employed:—

Reduced Iron,	grains	36
Arseniate of Iron,	,,	1½
Extract of Nux Vomica,	,,	9
Sulphate of Quinine,	,,	12
Extract of Gentian,	,,	24

Mix and divide into 18 pills.

A half gradually increased to one pill is to be taken thrice daily after food.

These pills must always be taken after food, never on an empty stomach.

Further the full dose is not to be taken all at once. To begin with, let a few of the pills be divided into two, and let a half be taken after meals thrice a day for two or three days, then let a half be taken after two meals and a whole one after the principal meal, and so let the dose be increased till at the end of a week three pills daily are being taken.

It is important also to notice that the use of the pills must not be stopped suddenly but gradually, a half pill less being taken for a couple of days, then another half less, and so on till in a week their use is stopped altogether.

Arsenic is apt to disagree with some stomachs. In such cases it may be altogether left out of the pills.

While these directions have been given, it is desirable to say that no unskilled person should attempt to treat such a disorder if skilled advice is obtainable.

Sudden suppression, as may arise from cold, usually happens in full-blooded people, and is accompanied by severe pain in the back, quick pulse, feverishness, flushed face, headache, &c. Let the patient's feet and legs be placed in a hot mustard bath for half an hour. She should be then put into a warm bed with warm foot-pan, and should have frequent mild warm drinks, following a large dose of opening medicine, castor oil for example. If this is not sufficient, and the case seems urgent, fever being high, place hot mustard poultices over the lower part of the belly, and give 5 to 10 grains of Dover's powder according to age.

Irregularity or Scantiness of the Monthly Discharge, in which the discharge occurs after more than usually long intervals, or at irregular intervals, or in which it occurs regularly but in small quantity, is commonly dependent upon conditions of the general health similar to those producing absence of discharge, and is to be treated on similar lines.

Excessive Monthly Illness (*Menorrhagia and Metrorrhagia*).—The monthly illness may be excessive, because occurring too frequently. Such conditions indicate a depressed condition of general health, and are also associated with disordered states of the womb. They are not uncommon at the period of change of life. The tonic treatment recommended for absence of the illness is likely to prove beneficial.

There are, however, two special forms of excess. One of these is called simply profuse menstruation, what is meant being that the discharge is too free or lasts for too long a time, returning at the regular periods perhaps. The proper term for this is **menorrhagia.** The other form is not strictly discharge at the monthly periods, but a loss of blood occurring at other than the monthly period, at least a discharge of blood from the womb, occurring independently of the monthly period. This is called **metrorrhagia.**

The first form, that of excessive loss at the period, occurs under various circumstances. It must be observed, however, that there is no absolute quantity of discharge to be regarded as the healthy standard (see p. 482). Each woman knows what, under ordinary circumstances, she is accustomed to, and that is her standard. The excessive loss may depend upon bad conditions of health, arising from Bright's disease of the kidney, scurvy, consumption, &c. Commonly it is a symptom of chronic disease of the womb. It is sometimes the only symptom of fibroid tumour of the womb (p. 503). In cancer of the womb, polypus, displacement, congestion, and in many other alterations in structure, it is present.

The excessive loss produces a blanched appearance of the patient, and according to the degree of excess is more or less exhausting. The second form is met with under similar conditions, and the first often leads up to and merges into it.

The **treatment** of both forms is practically identical. The patient should rest in bed as much as possible during the period, undertaking no exertion. If the loss of blood is great and threatening, whether during the period or not, she must lie in bed perfectly quiet and lying on

her back. Mild but nourishing diet in small quantities should be given often—milk, light soups, &c. The very valuable and most readily obtainable drug is ergot or spurred rye, in the form of the liquid extract. A half to one teaspoonful is given in water or syrup every third hour as long as necessary. Another useful drug is the tincture of witch-hazel (*Hamamelis virginica*, p. 835), in doses of five drops in water every third or fourth hour. A medical man would, in urgent cases, plug the passage by inserting pledgets of soft cloth, sponge, silk handkerchiefs, &c. In the intervals good nourishing food, bracing air, moderate exercise, &c., are valuable, as well as the iron tonic advised for absence of the discharge on the preceding page.

In certain cases of persistently recurring attacks, due to tumours, and threatening life, a surgeon might recommend removal of the ovaries, or other operative interference.

Painful Monthly Illness (*Dysmenorrhœa*).—Painful menstruation is exceedingly common, and many women who suffer severely at each period seek no advice nor relief, because they believe a certain amount of pain is a natural accompaniment of the illness. This is not so. Any actual pain is a departure from the proper state of affairs, and ought not to be endured, if it can be got rid of.

The **causes** of the pain are numerous, just as the cause of every other menstrual trouble may depend on a variety of circumstances. In one set of cases the cause is a mechanical one, and consists in some obstacle to the easy flow of the discharge, undue expulsive efforts of the womb being thereby occasioned. Thus the canal leading from the womb may be very small or contracted, the womb may be displaced and bent, so that the canal is encroached on, or at one point blocked by the bending, clots may form readily, and stop the way or require specially violent efforts to expel them, or the way may be barred by a tumour. All these instances come under this class of cases as mechanical causes of painful menstruation. Another set of classes often occurs in which the pain is of a congestive or inflammatory sort, and in others shreds of membrane and casts of the womb are expelled. In a fourth set the pain is more neuralgic in character, not seeming to depend on any special condition of the womb, while the pain in some cases arises from the ovaries.

The commonest cause of painful menstruation is some mechanical obstruction to the flow of the discharge, due either to narrowing of some part of the canal of the womb, or to some displacement. The occurrence of any clots or shreds of membrane will certainly increase the pain by the difficulty of their passage along the narrowed canal.

The **symptoms** of this variety are very intense pain, sometimes agonizing, leading in some cases to fainting, hysterical attacks, or even delirium. The pain often begins before the discharge, and is relieved when any quantity passes, as it sometimes does, in gushes. It begins deep in the belly, but radiates to the groin, thighs, and back. Headache and vomiting are common, and there is often tenderness over the womb and ovaries. The pain may persist throughout the illness. Moreover, the obstacle to the flow tends to produce a congested condition of the womb.

The cases dependent upon congestion have similar symptoms.

Those accompanied by discharge of shreds of the membrane are recognized by the presence of the membranous fragments, and the pain is most intense just before the passage of the membrane, after which it is relieved. When the pain is more ovarian than belonging to the womb, it usually begins a few days or a week before the discharge appears, and may cease with its appearance. It is felt in the situation of the ovaries, in the groin, and commonly on the left side, and there is tenderness over this position. Vomiting and hysterical attacks are common in it. Probably there are few cases really neuralgic in character, those classed thus being likely due to some obscure condition of the ovaries.

Treatment.—The general treatment of painful menstruation consists in rest in bed during the attack, and the employment of hot applications, hot-water bottles, hot fomentations, &c. Great relief will be experienced, in many cases, by the patient taking a hot bath, lasting for twenty to thirty minutes, before going to bed, on one or two nights before the illness is expected. The pain will be relieved by some preparation of opium or other similar soothing drug. The following pill is good for that purpose :—

Morphia, ...	$\frac{1}{12}$th	grain.
Extract of Indian Hemp, ...	$\frac{1}{3}$d	„
Extract of Hyoscyamus,................	$\frac{1}{2}$	„
Extract of Gentian, ...	1	„

Make into one pill.

Two or three of these may be taken at intervals of two or three hours between each pill.

Instead of this a dose of 25 to 30 drops of

laudanum, with 5 drops of tincture of belladonna, may be used.

While such a remedy is often necessary, the danger attending the use of any preparation of opium must be strongly pointed out. The desire for the drug becomes strong, and it is used more frequently in ever-increasing quantities. Many women contract a fatal opium habit from using it at such periods. In such a time of suffering, also, stimulants are sought, and relief is obtained from them. The craving for them grows just like the craving for morphia. Thus too many women have become the slaves to opium or whisky, which was originally taken for the relief of urgent suffering.

Under such circumstances it cannot be too strongly urged that everyone suffering in this way should not attempt to treat herself, but should seek competent advice. It is probable that a skilled medical man would discover some unusual condition, which was the cause of the pain, and which he might be able to rectify without the use of drugs, that might in the end prove more disastrous than the original ailment. Thus a displaced womb could be restored to its proper position, and perhaps the painful menstruation could be cured, a contracted passage could be widened, and other unhealthy conditions might be got rid of.

During the interval between two illnesses much relief may be obtained by attention to general conditions of health. Good plain food should be the rule; a daily movement of the bowels ought to be obtained by mild opening medicine, if necessary—for example, a wine-glassful of Hunyadi Janos mineral water each morning on an empty stomach. Opening pills should be avoided. The patient should be warmly clad, with flannel next the skin, and it is necessary to avoid all undue tightness of dress. Fresh air, moderate exercise, avoidance of fatigue, are all of the utmost consequence. Any gouty, rheumatic, or weakly condition of health, such as anæmia (p. 234), needs to be treated. If the pain is felt over the ovaries, 20 grains bromide of potassium, dissolved in water, may be tried every three or four hours.

AFFECTIONS OF THE BLADDER, &c., IN WOMEN.

Painful, difficult, or frequent passing of water very often occurs in women as a consequence of some affection of the womb or genital passage. Inflammation of the passage (p. 498) is apt to spread up to the canal leading to the bladder, and cause frequent desire to pass water, an act which is likely, under these circumstances, to be attended by a hot smarting or burning pain. The same condition may cause spasm at the neck of the bladder, and lead to inability to pass the urine. Specially likely is it that an irritating discharge will set up such a condition and lead to much pain and discomfort, a result that constant care and cleanliness would do much to avoid. A displaced womb, by pressure on the bladder, will readily set up an irritable condition, manifested by pain and a frequent desire to pass water, or will block more or less the passage from the bladder and occasion difficulty of micturition, as the act of passing water is called. Tumours connected with the generative organs may have similar effects. Besides the prominent symptoms of frequent or painful or difficult micturition, there is often produced considerable difficulty in walking, and in turn the walking aggravates the other symptoms. Painful and difficult or frequent micturition may also be quite independent of any disorder of womb or genital passage, and may be occasioned by some unnatural state of the urine, undue acidity, or otherwise altered characters, the result of disease of the kidney or bladder or some constitutional state.

Treatment.—Rest and the use of hot applications give very speedy relief. Heat may be applied in the form of hot-water injections, hot cloths, or hot bottles close up to the parts, or the patient may sit down in a hot bath. Medicated pessaries are also of great value. These are made of cacao butter, in the shape of miniature sugar loaves, some soothing drug being mixed with the cacao butter. The best are those made with extract of belladonna. Each pessary should contain 3 to 5 grains of this extract. The pessary is pushed well into the genital passage, a diaper is then put on, and the patient should rest for some time. This may be employed after the hot-water injection, bath, or fomentation. But the patient must bear in mind, that, though such treatment relieves for the time, it is necessary, if the cure is to be permanent, for any cause of the disturbance, that may be present, to be found and removed.

DISEASES OF PREGNANCY.

Derangements of the Stomach and Digestion are exceedingly common in pregnancy, are in fact almost constant, and are to be regarded as quite natural, if within certain

limits. They depend mainly upon the sympathetic nervous relationship existing between the womb and digestive system; to some extent they are due to the pressure of the enlarging womb, and in some cases may be very marked because of displacement caused by the increased weight of the organ. They may occur throughout the whole course of the pregnancy, but they are often worse in the early months, beginning within a few weeks of conception, and being markedly relieved about the period of quickening, when the womb rises up into the belly. Perhaps the relief at this time is due to the greater room for growth thus afforded, and the consequently lessened pressure. Some women, however, scarcely suffer at all from such disturbances, while in others the distress is excessive. It also, sometimes, happens that a woman who has been much disturbed for two or three pregnancies passes through another almost without them, and the reverse also often happens.

Vomiting is one of the commonest of these disorders, and because of this is counted as one of the earliest and most usual signs of pregnancy (see p. 487). It is only when excessive that it should receive treatment, and it often happens that nothing gives relief. The patient should begin by maintaining the regularity of the bowels, which is best done by a wine-glassful of Hunyadi Janos mineral water, taken each morning before rising. This affords much relief if regularly taken. The effervescing citrate of magnesia is also useful. Then careful attention should be paid to the diet, as the vomiting may be largely controlled by finding the food that agrees best. Marked relief is frequently obtained by taking a cup of warm tea before rising, or by breakfasting in bed, and not rising for some little time afterwards. If such means fail, let the patient try the effect of taking small quantities of food often, and among the kinds of food milk, and milk with soda, are to be preferred, or milk and lime-water. Used in this way barley-water is highly spoken of. Frequent sips of iced milk may be found to allay the irritability. Stimulants may seem desirable, such as brandy in soda-water, or brandy or whisky in milk. The only medicine to be recommended as a soothing agent is bismuth, which may be taken several times a-day in 10-grain doses in water, or 1-grain doses of oxalate of cerium may be tried. A pessary of belladonna (see PESSARIES) has now and again succeeded when other means failed.

In some cases, happily very rare, the vomiting defies treatment, and is so persistent, with even the smallest quantities of food, that the patient becomes much exhausted, and brought into a condition of great danger. It is under such circumstances that a medical man would consider whether he were justified in inducing premature labour. This is a question for a skilled physician carefully to consider; it is here only mentioned as a last resort when the life of the mother seems threatened.

Acidity, Heartburn, and Painful Digestion are other forms of disturbance, and sometimes are the only forms, vomiting being entirely or nearly entirely absent. Bismuth in 10-grain doses, or half a tea-spoonful of the ordinary bicarbonate of soda (baking soda), or bicarbonate of potash, dissolved in water, is useful for these disorders, though the relief is only temporary. To the soda, dissolved in water, a tea-spoonful of sal-volatile (aromatic spirits of ammonia) may with advantage be added.

Constipation is best met by the use of the Hunyadi Janos mineral water, as recommended for vomiting.

Looseness of Bowels may occur every now and again. It should be met if possible by change of diet, the use of lime-water and milk, &c. If these means fail, 5 to 10 drops of laudanum in water may be employed, but this is to be had recourse to sparingly and with care.

Perverted Appetite or **Loss of Appetite** is another of the troubles of pregnancy. The craving for improper articles must be resisted, but a feeble appetite must be coaxed, and careful dieting will usually be sufficient to meet it.

Disturbances of Breathing are happily not so common as those of digestion. The mere bulk of the enlarging womb will occasion some difficulty of breathing. To meet this the patient must dress in the most suitable way. Difficulty of breathing is occasionally due to asthmatical attacks or bronchitis, and where such exists it would be well to obtain competent advice without delay. (Refer to pages 270 and 273, where these affections are discussed.) Cough ought not to be neglected. In some cases its violence threatens to provoke a miscarriage.

Disturbances due to pressure are frequent in the course of the child-carrying period, and specially, as might be expected, towards the end of the period. The **bladder** is peculiarly apt to be pressed upon, and frequent passing of water, pain in the act, or difficulty in emptying the bladder may be experienced. Dribbling of urine may arise from pressure on the neck of

the bladder interfering with its proper emptying, and may be thus the result not of inability to retain the water, but from the bladder being constantly overfull. A bandage carefully adjusted while the patient is lying down will often relieve such symptoms by the support it affords to the womb. Occasionally the use of a belladonna pessary (see PESSARIES) or the application of hot-water pads relieves irritability. Sometimes the patient will overcome difficulty in making water by changing the position usual in the act of passing water, but sometimes it is necessary to pass the catheter to empty the bladder.

Dropsy, Varicose Veins, and **Piles** are frequent in pregnancy as the result of pressure by the enlarging womb on veins preventing the due return of blood. The feet and legs suffer from the dropsical swelling, and the veins of the inner side of the knee and also of the ankle become swollen and prominent, forming varicose veins (see p. 247). Sometimes the ankle becomes much discoloured, in consequence, as if it had been severely bruised. For these conditions there is no cure. They will in nearly every instance disappear after delivery. Some relief may, however, be given by supporting the womb with a bandage put on as the woman lies on her back, and by supporting the veins of the leg with properly-adjusted bandages. All garters should be discarded and nothing worn tight round the knee. Elastic stockings, if properly fitted, are very useful. The bowels should be regulated with the Hunyadi mineral water already recommended. Piles often also disappear after delivery. Certainly no operation for their cure should be undertaken during pregnancy. If they are painful, bathing with very hot water gives great relief, and the gall and opium ointment or the tincture of witch-hazel (the American Pond's Extract) may be applied to relieve pain and arrest bleeding. In this case regularity of the bowels is everything.

Dropsy during pregnancy may, however, be the result of an affection of the kidney, termed **albuminuria** (see p. 302). In such a case it affects not the lower limbs merely but the whole body, and is a much graver condition than the dropsy due to mechanical pressure. The legs are greatly swollen, and the face puffy. There are also other symptoms, such as headache, dimness of sight, and in severe cases convulsions. The symptoms may, however, not be so serious, and after delivery they may entirely disappear. But a patient who, during pregnancy, suffers from swelling not of the legs only but also of other parts of the body should seek competent advice at once. It is not a condition for which treatment can be definitely laid down here.

Another form of dropsy, called **dropsy of the amnion**, may be mentioned here. It has been pointed out (p. 485) that the growing child is inclosed within a double sac between the walls of which fluid is contained, the waters. In ordinary circumstances the quantity of fluid would not be more than 2 or 3 pints, but in some cases the quantity is enormously increased. It produces in such cases most excessive enlargement, and is a source of extreme discomfort to the mother, interfering with movement, affecting breathing, &c. It is usually after the middle of pregnancy that the excess shows itself, not much before the fifth month, and it is commoner in twin pregnancies. When the distension is very great the breathing may be so difficult that some treatment is needed. Nature has often afforded relief by the membranes spontaneously rupturing, inducing premature labour. If it were proved necessary, a physician would imitate this procedure. It is not a condition, however, threatening the mother, but it does seriously that of the child.

Nervous Affections are not uncommon during the child-bearing period. It is quite common for pregnant women to manifest marked alterations in character, an unusual irritability of temper, a tendency to fretfulness, capriciousness, or melancholy, hysterical tendencies also, the woman being easily moved to tears or laughter. Indications of nervous disturbances are also found in perversions of taste, smell, &c. More than this, however, there may be marked signs of mental disturbance, and actual insanity. Convulsions sometimes occur, which may be associated, as mentioned above, with the altered condition of the urine, called albuminuria. As these affections are more common during and after delivery they will be considered later (see p. 517).

Miscarriage and Abortion are both used to indicate that the offspring has been expelled from the womb before the full period of pregnancy is completed. Abortion is the word which ought to be employed when the expulsion takes place before the eighth month, before the period, that is, when the child has the chance of surviving, and miscarriage is employed after that period, when it is still possible for the child to live. The phrase **premature labour** is still

better to indicate the latter state of affairs. There is no doubt that the product of conception is very often expelled from the womb within a few weeks of conception taking place without the woman being aware of the fact. She thinks her monthly illness has only been delayed. The commonest period for abortion is between the eighth and twelfth week of pregnancy.

The **causes** are very numerous. Accidents, blows, falls, &c., indiscreet exertion in dancing, for example, irritation arising in the bowel from the presence of worms, or the occurrence of diarrhœa, irritation in the genital passage or womb itself, all these may cause it. It may be due also to disease, diseases attended by fever, or any serious disease whatever; it may be the result of a diseased ovum, of tumours connected with the womb, or displacements of the womb. Strong emotion may excite it, and various drugs act on the womb in a way to excite it to expel its contents.

It must be noted also that the womb may readily acquire a habit of expelling its contents at a particular period. If abortion has occurred once or twice about the same time, there will be special danger of the same occurrence about the same time in future pregnancies.

Symptoms.—The chief symptom, to begin with, is pain—pain in the back and in front also. If the abortion is very early, the pain may be trifling, but the more advanced the pregnancy, the larger will be the mass to be expelled, and the greater the pain. Previous to the pain, a cold uneasy feeling is experienced at the lower part of the belly in front, along with a sense of weight, and the morning sickness and fulness of the breasts may have disappeared. The pain lasts for a time, passes off, and after a longer or shorter interval, returns. A discharge of blood also appears, which varies in amount in different cases. On the quantity of blood which has been discharged one bases an opinion as to whether or not the threatened abortion can be prevented. If the discharge has been considerable, and repeated, and if the pains keep returning, there is little hope of averting the expulsion of the contents of the uterus. If the pregnancy is advanced to the formation of membranes and fluid, and if the membranes have ruptured and the waters escaped, that is conclusive evidence that the process cannot now be checked.

If any reliable information could be obtained as to whether the offspring were alive or not, that would be a great aid in solving the chief difficulty of the situation. If its death were certain, the expulsive efforts of the womb would be encouraged; if its life were certain, they would be restrained if possible. The feeling of coldness and weight referred to are held as indicating the death of the offspring. Should the pregnancy be advanced beyond the period of quickening the cessation of all movements on the part of the child would lead to the conclusion that it was dead. This must not be too readily accepted as proof. It has often happened that the movements have ceased for days, till the mother became convinced of the child's death, and yet it has been born alive. In some cases the expulsion of a dead ovum has not taken place for a long time after the death had occurred.

When the abortion or miscarriage actually occurs, the important thing to secure is that everything is expelled from the womb. It is always desirable, in order to make certain that this has occurred, for all clots, &c., to be kept till seen by the medical attendant. In abortion in the earliest months everything is usually expelled together in the form of a fleshy mass, but from the third month there is greater liability of something being retained, which will lead to subsequent trouble. After the sixth month the miscarriage becomes similar to labour at full time, but more easily accomplished.

Treatment.—The first and most essential part of treatment is rest, complete rest in bed, the patient lying flat, with head low. If the abortion or miscarriage is only threatened this is the first and chief means to ward it off. Unstimulating light diet is to be given, and always cold. If pain is the chief symptom, an opiate is very valuable, say 30 drops of laudanum, which would be best given mixed with a teacupful of thickish starch as an injection into the bowel. If a discharge of blood is the chief symptom acid drinks and a lead and opium pill is advised. Repeated doses of opiates should, however, never be given without medical orders. If the abortion is arrested, rest must be continued for a prolonged period, and great care exercised. If such treatment does not arrest the expulsive action, if the pains are returning at regular intervals in strength, and the discharge of blood is considerable, and certainly if the waters have come away, other treatment, designed to aid the process, is needed. For this purpose from a half to a tea-spoonful of liquid extract of ergot is given every third hour till everything is expelled.

A woman who has miscarried or aborted

must be treated in every way as one who has been delivered at the full time, and must be allowed as long a period of rest in bed afterwards. Further, such an one must remember that she runs special risks of repeating the same performance at a similar period of a later pregnancy, and must, therefore, take special precautions about such a time, avoiding undue exertion and fatigue, and, it is specially to be noticed, *avoiding all sexual excitement.*

Flooding is the ordinary term applied to profuse loss of blood from the womb. It may occur either before the period of confinement or afterwards. Of course loss of blood occurs in abortion, but it is attended usually by the pains, which indicate what is going on. Alarming losses of blood occur within the last three months of pregnancy, due to the placenta, or after-birth, occupying a peculiar position in the womb. This is called properly **placenta previa.** The after-birth is situated partially or wholly over the passage, through which during delivery the child must pass, and, therefore, it is separated either wholly or partially some time before the birth can occur. By this separation blood-vessels are opened, and the womb not being able, owing to its contents, to contract and close the bleeding vessels, a great loss of blood occurs very speedily. The actual determination of this condition can only be made by a medical man after a careful examination; but a profuse loss of blood occurring within the last three months of pregnancy, without any apparent cause, should cause a woman to seek immediate skilled advice. Sometimes there is no sign of this condition till the full time, after labour has set in, and then the loss of blood may be immediately so great that the life of the mother is threatened before any assistance can be obtained.

Treatment.—Medical aid cannot be dispensed with. All that others can do is to put the patient to rest on a hard bed, with low head, and to give low diet, cold, all stimulants being avoided. If the loss of blood is great and danger threatening before aid can arrive, attempts may be made to stop the flow of blood by plugging the passage. This is to be done by pushing up strips of lint one after another, or pieces of a silk handkerchief, till the whole passage is thoroughly packed. Tea-spoonful doses of the liquid extract of ergot may also be given in cold water every third hour.

Flooding after delivery will readily occur if the after-birth has not been expelled. It also occurs when everything has gone on satisfactorily, the after-birth has been removed, and all has seemed well, owing to the womb relaxing, because of want of vigour, and permitting the torn vessels again to open and pour out blood. The **symptoms** are not only the visible flow of blood, but the patient complains of faintness or dim sight; she is white and cold, with clammy skin. In the former case the after-birth must be got rid of. A medical man would probably pass up his hand into the womb and remove it. In the absence of such assistance let a large dose of the liquid extract of ergot be given, one to two tea-spoonfuls. Let someone place the *cold* hand over the lower part of the woman's belly and rub, with the design of exciting the womb to contract. Cold water may be dashed over the belly and cold water injected into the genital passage by an enema syringe. Similar treatment is to be adopted if the bleeding occurs after the after-birth has been removed.

Molar Pregnancy or Blighted Ovum.—Sometimes the product of conception dies without abortion speedily occurring. Owing to some part of it remaining connected with the womb, growth goes on, the membranes undergoing thickening and degeneration. This may continue till at length a fleshy mass is discharged called the **flesh-mole.** In other cases one of the membranes undergoes a peculiar development, so that a mass is produced resembling a bunch of currants, when seen floating in water coloured with some of the discharged blood, like a mass of "white currants in red currant juice." This is the **vesicular mole.**

Symptoms.—In each case the woman usually suspects something is wrong. The usual symptoms of pregnancy are experienced for a time, but the enlargement of the belly is much more rapid than usual. In the case of the fleshy mole, the growth is so rapid that at the end of the third month the enlargement is as great as is customary at the end of the fifth. In the case of the vesicular mole the normal symptoms go on till about the third month, and then enlargement becomes very rapid, and is more towards the side than upwards. The other usual symptoms are indistinct, the patient feels differently from what she did in other pregnancies. Watery discharges, mixed with blood, may occur, and the feelings of movement of the child are not experienced.

The mole is usually expelled after six months. It has sometimes occurred in twin pregnancy

that one of the ova has undergone such degeneration, and the other has followed a normal development, so that at the sixth month a living child has occupied the womb along with a vesicular mole. In such a case the danger is that the expulsive efforts of the womb do not end with ridding it of the mole, but go on to the expulsion of the fœtus, at a time when it cannot survive. Some cases are recorded, however, in which the mole was expelled, and a healthy living child was born at the full time.

Treatment of such cases rests, of course, with a physician. In any case where such cannot be obtained soon, and there is considerable watery and bloody discharge, especially if some of the currant-like material has been expelled and shows clearly the nature of the case, error can hardly be committed by giving full doses (teaspoonful) of the liquid extract of ergot of rye, every two or three hours, as long as seems necessary.

DISEASES AFTER CHILD-BIRTH.

Flooding (*Hæmorrhage*) has already been sufficiently discussed in the previous paragraphs (p. 515).

Milk Fever.—On the third day after delivery the rush of milk to the breasts becomes usually very marked, and is frequently attended by considerable disturbance, feverishness, quick pulse, and headache. The breasts are very full and may be hard, and markedly knotted and painful. This is the condition called **milk fever**, and also called popularly a **weed.** If care has been exercised all through the period of delivery and after it, and everything has been scrupulously clean, if also the directions given on p. 496 have been followed, and in particular if the child has been regularly put to the breast every third hour (see p. 438), the chances of such a condition arising are extremely small.

Treatment.—Give a strong dose of opening medicine, a double-strong seidlitz-powder being preferred, or a full ounce of castor-oil. Put the child regularly to the breast every 2½ hours. If, owing to the swelling of the breast, the nipple is below the level of the breast, let it be pulled out by means of a breast-exhauster; and if the child cannot empty the breast, let the breast-exhauster be used as well. It is necessary to keep down the swelling in every way possible. Much relief will be given by laying over the breasts a soft handkerchief, soaked with ice-cold water. This may be renewed every quarter of an hour or so, if it is giving relief, but care must be taken not to overdo this, and not to permit the mother's clothing to become wet in the process. Warm applications, in some cases, are advised, but are to be used at first with caution. The cooling application should first be tried. If the breasts are knotted, gentle light rubbing with oil aids their relief. Meantime liquids must be given to the mother sparingly, and more solid food given. She may suck a small piece of ice to relieve thirst.

If, within a very few hours, these measures have not given relief, 10 grains of Dover's powder may be given in water, *but not until the bowels have been freely opened.* A second may be given in four hours, and, if it seems useful, a third six hours after the second, but no more without advice. The bowels will probably require to be opened again by medicine, as the powders have a binding effect.

Affections of the Breast after child-birth are very commonly due to the constant worry and irritation of cracks and fissures of the nipples. These are to be avoided by regular nursing, by carefully bathing the nipples after each nursing with cold water and drying them, and by the use of some agent which will toughen the skin, of which the best is glycerine of tannin, or glycerine of borax. It is not a matter of wonder if a mother suffers from tender nipples who permits her child to be continually at the breast, so that one nipple or another is constantly in the child's mouth. Some mothers suffer from such an excessive flow of milk that the dress is continually wet and the breast continually in a milk-bath. This will naturally make the skin tender and readily crack. Keeping the breasts as dry as possible, and limiting the flow of milk, if possible, by dieting, are the remedies. If the nipples are hacked and painful, the use of a nipple shield (see Plate VIII.) during nursing gives much relief, the other treatment already indicated being employed.

It is needful to bathe off, with cold water, the tannin and glycerine or other application before putting the child to the breast.

Abscess or **"Gathered Breast"** often results from neglected cracks and painful nipples. The breast becomes full and swollen and painful, especially over one part, which also becomes hard. The breast should be treated as recommended under milk-fever, first with the iced-water, and then, if it fails, with hot water

applications. A brisk dose of opening medicine (seidlitz-powder) should be given. If matter forms, it must be "let out" by the abscess being opened, and should on no account be allowed to burst.

Whenever the breasts are large and swollen, great relief is given by a bandage passing under the affected breast and over the opposite shoulder, so as to support it.

It is also necessary to keep down the swelling of the breasts as much as possible by regular removals of the milk. If this is not properly done by the child, a breast-exhauster, or breast-pump, must be secured at once, and the milk must be frequently drawn off by its means. The exhauster and its mode of application are shown in Plate VIII. It is advisable to apply the exhauster every two hours or so, to remove by its means small quantities of milk frequently rather than to attempt to remove a large quantity at one time. If this is done and the other measures advised are adopted, threatened inflammation of the breasts will often be speedily subdued.

Convulsions occurring during pregnancy or labour, or after child-birth, are of very serious meaning. They are commonly due to the condition known as albuminuria (see pp. 295 and 513), although they may occur without such a condition, caused, as some believe, by a too watery condition of the blood inducing a state of bloodlessness (ANÆMIA, p. 234) of the nerve centres.

Symptoms.—Convulsions may occur without any warning, but usually warning of the coming attack is given by the occurrence of headache, usually of the front of the head, of a very intense kind, and likely to be continuous when the fit is near at hand. Another warning sign is derangement of vision, dimness or cloudiness of sight, or some other disturbance of clearness of sight. In a few cases severe pain is felt over the pit of the stomach. One sign which ought not to be disregarded is puffiness of the face, and swelling of the ankles, feet, and external genital organs. Such a condition ought to lead to immediate medical advice. The fit itself is of a marked kind. The eyes are fixed, within a few seconds the face and eyelids are spasmodically twitched, the eyeballs roll, and the face is pulled down first to one shoulder and then to the other, the mouth being also twisted, and the upturned eyes show only the white part of the ball. The convulsive movement then passes quickly over the rest of the body, and for a little the whole body is stiff, head being bent back, limbs stretched out, and hands clenched. After a brief period irregular spasmodic movements occur of great violence. The face is violently twitched, the arms jerked, the tongue is often caught between the teeth and severely bitten, and froth mixed with blood from the tongue escapes from the mouth. Breathing is suspended till the face becomes purple. Motions from the bowels and water from the bladder are often passed. All this time there is complete loss of feeling and consciousness. As the fit passes off the spasms become less, the movements gradually cease, breathing becomes natural, and the face loses the purplish hue, and consciousness may be soon restored, or the patient may lie in a heavy torpor for some hours. When consciousness is restored the patient complains probably of headache and a dull stupid feeling. One attack may succeed another, consciousness not returning in the intervals, or there may be but one attack altogether.

The more severe and prolonged the attack, and the more frequent its recurrence, the graver is the case, though the author has seen one attack follow another for a couple of hours, and recovery take place. One in every three or four cases proves fatal.

If the convulsions occur before labour has set in they are extremely likely to provoke labour, and thus the life of the child is threatened. When labour is brought on it is often accomplished with great rapidity. The birth of the child has, however, a tendency to lessen the severity of the attack.

Treatment.—Very little can be done by an unskilled person. A medical man would probably administer chloroform, and if labour had begun would, if possible, effect delivery. Harm would not be done if, when medical aid was not obtainable, a draught containing 20 grains of chloral hydrate, dissolved in water and simple syrup, were given immediately after one attack to prevent, if possible, a second. The dose could be repeated in three or four hours.

Insanity may occur during the child-bearing period, during labour, or after delivery. It is most common in those with child for the first time, and in many there is an inherited tendency. In cases occurring during the child-carrying period, or after delivery, the commonest form is melancholia, evidenced by great depression of spirits and delusions, and when the case

is a severe one there is a tendency to suicide. These cases are more apt to occur in weakly, ill-nourished women, or those who have been much reduced by frequent pregnancies, prolonged nursing, or intemperance. Insanity during the progress of labour is frequently in the form of maniacal excitement, occurring during the most painful part of the process. The attack of mania may also occur some time after delivery, within a week or ten days, and occurs suddenly, or after a period of sleeplessness. There is considerable fever, small throbbing pulse, and bright eyes. The patient regards her attendants with suspicion. She talks excitedly, and the talk passes into raving, and she may attempt her own or her child's life. There is great sleeplessness, and the milk and discharge cease. Digestion is very seriously disturbed, the urine is high-coloured and scanty, and the bowels usually costive, though they may be loose. Recovery occurs in nearly three-fourths of the cases, that from mania may be within three or four weeks. Melancholia is less threatening to life but more to reason. It may last from a few weeks to a year or more, but most of the recoveries occur within six months.

Treatment.—Mania occurring during labour is met by chloroform. If it occurs afterwards the bowels should be unloaded by means of a simple injection of warm water and soap, and 20-grain doses of bromide of potassium in water may be given every four hours. But such cases are too serious and demand too much skill and care to be treated by any but qualified persons. The melancholic form needs, above all, careful dieting and quietness, freedom from worry and annoyance, kindly and watchful attendance, which had better be given by strangers than by the patient's own friends. A woman who thus suffers, or has suffered, should not attempt to nurse her child.

Puerperal Fever (*Child-bed Fever*).—This is one of the most appalling diseases that may follow child-birth. In most cases it is fatal within a very short period, ten days or so after delivery. It may be regarded as due to the passage into the blood of some poisonous material, probably of the nature of a living organism, such as has been discussed in Section XIII., which multiplies in the patient's body, and produces by its activity all the symptoms of the disease. The poisonous material may come (1) from the patient herself, or (2) may be introduced from without by, unhappily it is so, the doctor, the midwife, the nurse, or other attendant, or (3) as contagion from some other disease. Thus, to take examples, a patient may have had a miscarriage, the whole of the after-birth, membranes, &c., may not have come away. The retained portions may undergo changes of decomposition in the womb. Suppose now the woman again becomes pregnant. After delivery some of this decomposed material may pass into the blood and occasion the fever. Or a similar thing may occur at an ordinary confinement, fragments of the after-birth may remain behind, undergo putrefaction, and occasion the disease. Thus the woman may infect herself. A medical man may convey the disease by attending a confinement after assisting at a *post-mortem*, or after dressing foul wounds, &c. Similarly it may be occasioned by the use of unclean instruments, sponges, syringes, &c. An example of the third means of communication is afforded by erysipelas and scarlet fever. These diseases attacking a woman recently confined assume extremely violent and fatal characters, due to the peculiar condition in which necessarily the woman happens at that time to be.

Puerperal fever is a contagious disease. The danger of it being carried from one suffering from it to another patient in the process of confinement is enormous. No conscientious medical man will go from a case of puerperal fever to attend another confinement case without previously taking the greatest precautions against carrying the disease with him.

The disease, it will thus be understood, does not assume necessarily the same form in each case. In one apparently the poison is absorbed in a very fine form, and multiplying in the blood produces violent fever, diarrhœa, delirium, &c. In others it is absorbed, as it would seem, by the mouths of the open veins of the womb, in the form of larger particles, which, being carried with the blood current through the body, are arrested in various places, and form small abscesses. In such cases little abscesses may be visible on the skin, on the fingers, &c. In other cases the disease is in the form of an acute inflammation within the belly, as peritonitis (see p. 190), or as inflammation of the womb itself. Inflammation of the lungs and other organs may speedily arise in the course of the disease, due, doubtless, to the conveyance to these organs of some of the poisonous material.

Symptoms.—All of the various forms cannot be described, but we may state in some detail the characters of the fever in general. It begins

usually within three or four days after delivery, perhaps with a shivering fit (rigor), headache, and depression. The fever soon runs up to a considerable height, 103° or more by the thermometer (see p. 10). The pulse is rapid and feeble, the skin dry as well as hot; sometimes there is much sweating, and the sweat has a peculiar odour. The discharge from the genitals may cease; sometimes it does not, and the discharge is foul-smelling. The formation of milk is usually arrested. The bowels are loose, and the motions very offensive. The tongue becomes brown and dry, and little brown masses (*sordes*) form on the lips. Vomiting is frequent, the vomit being offensive. There is usually some amount of pain in the belly, which may become much swollen, adding to the distress. If muttering delirium sets in, and the patient's hands wander about picking at the bed-clothes, the case is as grave as can be. A very hurried feeble pulse, and rapid panting breathing, indicate sinking from exhaustion.

In other cases, at the very beginning of the fever, the patient complains of acute pain in one spot, usually low down in the belly, and the pain is apt rapidly to extend over the whole belly, which becomes much swollen, and is so painful that the mere weight of the clothes is distressing. To obtain some relief the patient lies on her back, with her knees drawn up. In such a case, instead of the bowels being loose, they are usually obstinately costive. Later on severe looseness of bowels sets in.

Treatment is too often utterly in vain. But if everyone were scrupulously careful cases of this disease ought to become exceedingly rare.

Moreover, the variety of the disease is so great that no one method of treatment is suited for each case. While stating this very strongly, we may even in such a very serious disease go on the same principle that pervades this book, and indicate general lines of treatment that may be adopted by any unfortunate enough to have no medical aid within reach. It is best to begin by clearing out the bowels with a large injection of tepid water, three or four pints. Nourishing food and stimulants must be freely given. Milk, eggs, nourishing soups, such as mutton soup, beef-tea, hough soup, &c., should be given in small quantities often, unless very loose bowels prevent much use of soups. Their loosening effect on the bowels may be to some extent checked by thickening them somewhat with corn-flour, &c. Whisky or brandy should be given in small quantities with milk to the extent of three or four ounces (one to two wineglassfuls) per day, if it seems to agree. Port wine is also useful and champagne. The fever is somewhat held in check by large doses of quinine, 10 to 15 grains every fourth or sixth hour; and to this may be added 10 grains of Dover's powder, if it seems to agree with the patient. If there is pain in the belly, a thick pad of flannel should be lightly wrung out of hot water, sprinkled with turpentine, and laid over the belly. This is kept on and repeated till the whole surface is red. If discharge from the genitals is fœtid, injections must be used with an enema syringe, fitted with a long delivery tube. Water, rendered pink with Condy's fluid, is employed to the extent of two or three pints, or carbolic acid solution of a strength of one ounce of the acid to two pints of water. This injection may be repeated twice daily. Great care must be taken that the injected fluid escapes freely. The patient's room must be freely but carefully ventilated.

STERILITY.

Sterility is want of the power of reproducing offspring, and is to be distinguished from impotence, which means inability for sexual intercourse. Sterility is not necessarily the fault of the wife. It may also be due to defect in the husband. In all cases it is desirable that this should not be overlooked, though here only sterility in the female will be considered.

In the first place, it may be that the sexual act is not duly performed. This is more frequent than might be supposed, for neither husband nor wife cares to consult even the medical attendant when the act of intercourse is attended with difficulty. Such a condition is called **dyspareunia.** Sometimes the genital passage of the female is so narrow, either naturally or as the result of inflammatory contraction, as to cause the difficulty, or the presence of painful spots or excrescences renders the act so painful that it is discontinued. The writer has treated such cases, in which this condition had existed for years without any remedy being sought, because of the idea that relief could not be obtained. It should, therefore, be plainly stated that this idea is in many cases erroneous, and that often a cure is easy of accomplishment, involving no severe or heroic method of treatment. Supposing, however, the sexual act to be duly performed, and supposing no defect to exist in the husband, the intercourse may be barren, from a variety of causes. The cause may lie in the ovaries

(p. 480), where the ova are developed, or in the tubes (fallopian tubes, p. 480), down which the ova should be conducted to the womb, or in the womb itself, or in the genital passage.

In rare cases the ovaries are absent or imperfectly developed, and do not perform their function of producing the female element in the reproductive act. It may be that the ovaries have been mature, but have been destroyed by inflammatory or other disease. In some cases the ovaries are displaced, and the ova are ripened but do not find their way to the fallopian tubes. Inflammation may have blocked the tubes so that the ova cannot pass down to the womb. Again, the fault may exist in the womb, which, in very rare cases, is altogether absent or has never grown to maturity. More commonly displacement or inflammation of the womb is a cause of sterility, the displacement preventing the due meeting of the male and female element in conception, and inflammation rendering the womb unfit for its duty of receiving and retaining an ovum which has undergone the changes of conception. In many cases the discharge from a womb that is the seat of such a disease is destructive to the life of the male element, and conception is thus prevented. In other cases of sterility tumours of the womb are the cause. Sometimes the cause is a very contracted state of the mouth and neck of the womb preventing the passing upwards of the fluid from the male. An inflammatory condition of the genital passage, specially such as is attended by a profuse discharge, produces sterility by the injurious effect of the discharge on the semen from the male.

Treatment in each case depends on the cause of the failure. Displaced and inflammatory conditions of the womb, as well as contracted states of the neck and mouth of the womb, &c., are all open to treatment, and the treatment in many cases is attended by the desired result. But women ought to be warned to trust only the opinion and advice of well-informed and conscientious physicians.

NERVOUS DISEASES OF WOMEN.

Hysteria, Catalepsy, and Trance.

Hysteria (Greek *hustera*, the womb).—This is so remarkable and amazing a disease, having so many varied forms, and producing so many perplexing manifestations, that it is doubtful if any but the briefest notice of it is necessary in a work like this. It is a puzzle and plague to nearly every physician. It is apparently due to a peculiar nervous condition, not necessarily attended by any structural change or disease in the nervous organs. It does occur rarely in men, but is very common in women, most frequently between the ages of fifteen and thirty, and specially between the ages of fifteen and twenty. Very commonly it is associated with some disturbance of the genital organs, often slight in itself, but sufficient in the case of nervous girls to excite the manifestations of the disorder. In those liable to nervous disturbance it may be induced by too luxurious and indolent habits, by unfortunate surroundings, badly directed training, and various other causes. The fact that men are, though rarely, affected with hysteria, is sufficient proof that it is not necessarily related in women to the genital organs. Yet it must never be overlooked that some disorder, perhaps slight, of the organs of generation may be the exciting cause in women. In those liable to it, some such disturbance may occasion an attack, and the continuance of the condition may cause repeated recurrences of the attacks for a prolonged period. It is always, therefore, desirable to make sure that there is no such exciting cause at work, and this can only be done by a skilled physician.

Symptoms.—Hysteria may produce symptoms referred to every organ of the body. Symptoms related to the digestive organs are frequent, such as loss of appetite, obstinate vomiting, costiveness, excessive development of gas in the bowels. Disturbance of the heart, fainting, &c., are common. Spasmodic seizures and fits of various kinds are of common occurrence. It is a spasmodic contracting of the throat, often excited by flatulence, that gives rise to the feeling of a ball in the throat common in hysteria, and which has been called *globus hystericus.* Paralysis of the legs, loss of voice and speech, loss of feeling in various parts of the body, may all be the result of a hysterical condition. On the other hand, excessive tenderness of some parts is frequent. Hysterical neuralgia, pain in a joint, in the breast, in the head, or over the stomach, are common. The determination of the true nature of these disturbances is a matter of great difficulty. The mental condition of hysterical persons is also peculiar. They are nervous and excitable, prone to laugh or cry at trifles, with little control over their emotions, irritable, querulous, and quarrelsome.

Treatment.—The main element in treatment is firm and judicious control. If the person can

be removed from the care of anxious friends and placed entirely under the discipline of strangers, much benefit will result. Hysterical convulsions can usually be cut short by dashing quantities of cold water about the person's face.

Catalepsy is a peculiar nervous condition, in which the patient loses all consciousness. At the same time the muscles of the body become so stiff, that if a limb be placed in any position, no matter how unusual or difficult to maintain in ordinary circumstances, that position will be kept for a considerable length of time. The condition may last from a few minutes to several hours; and it may pass off suddenly or slowly. It is met with usually at the same age as hysteria, but it has occurred at as early an age as 5 years, and also in advanced life. During the attack the face is without expression and pale, and the movements of breathing are slowed, as also is the action of the heart.

The patient retains the position in which she was when seized. The muscles become rigid, and after this stiffness is overcome they become pliant, and can be moulded, as it were, like wax, into any position consistent with the integrity of the parts. This position will be maintained till the muscles become exhausted.

The surface of the body may become so cold that, the pulse and breathing being barely perceptible, the condition may be mistaken for one of actual death.

Recovery is usually gradual. Attacks may occur at regular intervals, or irregularly and at long intervals; and they may last a variable time, from a few minutes to some hours.

Trance is a condition resembling sleep, which usually comes on suddenly, without any apparent cause, and from which the person cannot be roused.

It occurs chiefly in women between the ages of twelve and thirty. It is a rare condition. The subjects of it are usually hysterical, and it occurs in some cases as the result of exhausting disease, or excited by some emotional disturbance. It may last for a variable period, from several hours to many weeks or months. During its occurrence the countenance is pale, and the limbs are relaxed. No attempt at rousing produces return to consciousness, while the attack lasts. In most cases the mental functions are in abeyance; but sometimes the person knows what is going on, though unable to make the slightest movement. The action of the heart is diminished, and the breathing reduced. The bowels are moved, and water passed, as in health. When the trance lasts for a lengthened period, the patient partially rouses at intervals, takes food in a mechanical way, and then relapses into stupor. Recovery may take place slowly or suddenly. Most cases recover.

During the attack the nourishment of the person must be maintained by nourishing injections.

Ecstasy is a similar condition, in which, however, while the person is unconscious of impressions from without, the mind is possessed with some fixed idea, often of a religious character. The pulse and breathing are much reduced, the limbs remain in a particular attitude, and the countenance is pale, the eyes wearing a look of absorbed rapture.

PART II.

HYGIENE, OR A CONSIDERATION OF THE EXTERNAL CIRCUMSTANCES WHICH AFFECT THE HEALTH OF INDIVIDUALS AND COMMUNITIES.

INTRODUCTION.

The word *hygiene* is originally French, and means the science of health. It is derived from the Greek *hugieinos*, meaning "good for the health." It implies the study of everything outside of a person's own body which has an influence on his health. In the introduction to Part I., health has been viewed as the result of the harmonious co-operation of all the organs of the body in a sound condition. These we might call the internal conditions of health. It is clear, however, that if we limit our view to these internal conditions, we overlook a large number of circumstances which have an immediate and constant influence on the state of the body. Disease is more frequently due to a cause acting from without than to some condition originating from within. If, therefore, we are to have a fair all-round view of the conditions of health, we must give a careful study to the surroundings of a person, and observe how he is affected by them, we must study the conditions external to him, which directly and more or less constantly have a relation to his life. It is with these surroundings that the science of hygiene has to deal.

Now, the most striking of the outside agencies which constantly influence the bodily condition are the food a person eats, the liquids he drinks, and the air he breathes. These have already been considered (in Part I.), so far as was needful for our understanding of their general use within the body. But all details regarding, for example, the nature and composition of foods, the sources of foods, and the relation between their composition and their value to the human body, the varieties of liquids in common use, their varying properties and consequent effects upon the body, the various atmospheric conditions included under the term climate, and the influence they have upon human life, have been omitted in Part I. as foreign to the immediate purpose in hand. Yet they are all of the utmost importance. Again, the activity of the skin depends largely on the degree of heat and moisture of the external atmosphere, and the activity of the skin is remarkably related to the action of the kidneys, so that a change in the external atmosphere will profoundly affect the whole body. We can modify or alter the influence exerted by the atmosphere by the nature and amount of clothing worn. So it becomes of extreme interest to ask how and why clothing influences health. Further, while a person cannot voluntarily or directly affect the action of his heart, the activity of his circulation, or the rate at which his liver and kidneys remove waste from the body, he may indirectly but powerfully influence all these by the kind of work or exercise he engages in. Therefore the effects of exercise on health, whether in the form of work or play, become an important part of the study of hygiene.

In the next place we must remember how materially man alters the natural conditions of life, how very different, for example, may be the atmosphere he breathes from that he was, so to speak, designed to breathe, because of the nature of the dwelling in which he lives, because of the alteration of the composition of the air from the addition to it of foreign particles, produced by various kinds of industry, such as chemical works, or by metal grinding, such as brass grinding, &c., or because of additions to the air of organic impurities, such as are cast off from his own body in the course of its natural activity. So that in face of the ever-increasing developments of modern industry, the continual new departures which modern industrial progress renders necessary, and the new and unusual conditions of life they create, it becomes more and more a daily and urgent necessity that the principles of health should be studied, and their bearings on new conditions realized.

Every one who endeavours to arouse the public interest in such questions, and to direct the public attention to them, is met by the question, "How comes it that our forefathers

lived healthy and useful lives in spite of their ignorance of such principles, and how should we not be as healthy as they without such knowledge?" The answer is, that the tendency for men to mass themselves together in large communities has never been so marked as in quite recent times; and it is the formation of large communities and the growth of crowded cities that create conditions hostile to health, and render necessary the deliberate facing of the question how, in spite of such hostile conditions, health may yet be preserved. Men must be considered in the relationship they bear to one another, simply in virtue of their proximity to one another, and in view of the influence they exert on one another because of that proximity.

Each individual gives off organic material from his lungs, from his skin, from his kidneys, and from his bowels, which it is highly undesirable that his neighbour should get the benefit of, and exceedingly undesirable if he happens to be suffering from a disease, which may be communicated by such means, as many diseases may be (see Part I., section XIII.). In the ordinary course such organic materials would undergo destruction by natural agencies. In contact with the air they suffer oxidation or combustion, by which they are reduced to simple and harmless substances. Material cast off from the body and thrown upon the surface of the earth rapidly undergoes such combustion; discharged into the running stream, it is equally destroyed by the agency of the oxygen contained in the air dissolved by the water. Now, while "the self-cleansing properties of nature" are sufficient to effect their purpose speedily, where men live in scattered groups over a country, it is very different when men are so crowded together that the amount of air-space and earth-space for each becomes reduced to a minimum. To take an actual illustration, "there are ten rural counties in Scotland inhabited at the rate of only 41 persons per square mile, on the average of the ten years 1866–1875, while in Glasgow we endeavour to live in the proportion of 53,224 persons per square mile." Supposing the persons to be equally distributed over the square mile, then "in the ten rural counties each man, woman, and child enjoys an ample area of 16 acres, and is 296 yards from each of his or her neighbours; while in Glasgow each citizen is 'cribbed, cabined, and confined' within less than $\frac{1}{80}$th of an acre, and is only 8 yards from his nearest neighbours." In the former condition of affairs the amount of air-space and earth-space is sufficient to ensure the constant maintenance of healthy surroundings and the speedy destruction, by natural means, of waste organic products. In the latter case the amount of waste is so enormous that nature has no room to deal with it, and special means need to be devised for the removal from the community of the waste, whose accumulation means serious injury to health. One is, therefore, not surprised to learn that "in the rural counties only 17 per 1000 of these happy people die annually, while in Glasgow fully 30 perished in each of the years from 1866 to 1875. Shall we say that in Glasgow we choke and hustle each other out of existence?" (Dr. Russell). In proportion as men crowd together, in a similar proportion does disease multiply and the death-rate increase. So we get hold of "the idea, that vast as are the resources of nature, they are not without limits; and that as we add house to house, and man to man, in our cities, we had better have a care how we do it." Thus hygiene does not only study health in relation to the individual but in its bearings on communities, and we have the departments of private and public health established. Inasmuch, then, as each individual in a community may, by his mode of life, by its effects on his surroundings, seriously affect the welfare of his neighbours, and inasmuch as his neighbours may have no power themselves to put an end to his injurious influence, it becomes necessary to have some state regulation of the conduct of individuals in relation to a community, and there thus arises what is termed "State Medicine."

Hygiene, then, embraces within its scope not only the study of the principles of health in regard to the individual, the food he eats, the water he drinks, the air he breathes, the clothing he wears, the exercise he engages in, the dwelling in which he lives, the occupation at which he is employed, and the means by which the cast-off waste products of his body are removed from his immediate surrounding, but also, in regard to communities, the steps which are to be taken to prevent the accumulation of such waste products and the consequent spread of disease among the community, and such like questions.

In this portion of the book it will be our business to study food, drink, air, exercise, clothing, removal of waste, ventilation, drainage, &c., in their bearings on health, in an order such as has been indicated.

Section I.—FOODS.

Food and Energy:

The Meaning of Energy—Potential and Actual Energy;

The Sources of Energy; The Conservation and Transformation of Energy;

The Energy of Heat and of Mechanical Work—The Mechanical Equivalent of Heat

Food as a Store of Energy—The Energy obtained from various Foods by Burning.

The Chemical Composition of the Human Body:

Chemical Elements found in the Body;

Chemical Compounds found in the Body—Water, Inorganic Salts, Proteids, Starches and Sugars, Fats—Percentages of Proximate Principles of the Body.

The Nature and Chemical Composition of Food-stuffs:

The Classification of Foods—Proximate Principles of Food (Water, Salts, Proteids, Starches, Sugars, Fats);

The Fate of various Food-stuffs and their Uses in the Body.

The Composition of Animal Foods:

I. *Nitrogenous Animal Foods*—

Butchers' Meat—Beef, Mutton, Pork, Veal;

Various Parts of Animals—Liver, Kidney, Tripe, Bacon, Foie Gras;

Poultry and Game; Eggs;

Fish—Whiting, Haddock, Cod, Sole, Salmon, Herring, Mackerel, Eel, &c., Caviare, Poisonous Fish;

Shell-fish—Lobsters, Crabs, Oysters, Mussels, &c.;

Milk—Average Composition of Different Animals' (Cow, Ass, Goat, Mare, Sheep), compared with Human Milk—Characters of Milk and Variations due to Feeding, &c.; Cream, Buttermilk, &c.; Koumiss;

Cheese—Composition and Qualities of various kinds (Stilton, Cheddar, Gorgonzola, &c.);

Various Animal Foods Compared.

II. *Non-Nitrogenous Animal Foods*—

Butter, Lard, Dripping, Oleo-margarine or Butterine, &c.

The Composition of Vegetable Foods:

I. *Nitrogenous Vegetable Foods*—

Cereals or Grains—Wheat Flour and Bread, Food-stuffs made from Wheat (Semolina, Macaroni, Vermicelli), Oats and Oatmeal, Barley, Rye, Maize or Indian Corn, Rice, Millet, Buckwheat, Dari or Durra;

Leguminous Plants or Pulses—Peas, Beans and Lentils;

Tubers and Roots—Potatoes, Sweet-potato, Yam, Carrots, Turnips, Beet-root, Parsnip, Jerusalem Artichoke, Radishes, Salsify;

Herbaceous Articles—Cabbage, Cauliflower, Savoy, &c., Spinach, Celery, Rhubarb, Sea-kale, Onion, Asparagus, Lettuce, Endive;

Fruits—Cucumber, Vegetable Marrow, Tomato, Apples, Pears, Plums, Grapes, Figs, Dates, Bananas, Bread-fruit, Nuts and other Fruits;

Fungi—Mushroom, Morel, Truffles;

Sea-weed—Moss, &c.

II. *Non-Nitrogenous Vegetable Foods*—

Starchy Foods—Sago, Corn-flour, Arrow-root, Tapioca and Cassava, Tous-le-mois;

Sugary Foods—Sugar, Treacle and Syrup, Honey, Manna;

Vegetable Oils.

III. *Condiments.*

Comparison between Animal and Vegetable Foods.

The Adulterations of Food-stuffs, and Unwholesome Food.

The Digestibility of Food:

Time occupied in Digestion of Different Foods;

The Quantity of Different Foods that is Digested.

The Principles of Cooking.

The Construction of Dietaries:

Quantity of Food required per Day—Standard Diet, Starvation Diet,

Variations in Quantity caused by Age, Sex, Work, or Exercise;

The Regulation of Diet according to Season or Climate;

Diet for Training;

Economy in Diet—What Kind of Diet yields Everything required for Health and Work, at least cost?

Effects of Excessive or Deficient Diet;

Diet suitable for Special Bodily Conditions—Corpulence (Banting's System), Diabetes, Gout, &c.

Diets for Invalids and Infants—Beef-tea, Artificially Digested Foods, Analyses of Various Infants' and other Prepared Foods.

The Preservation of Food.

FOOD AND ENERGY.

The Meaning of "Energy."—The human body has already been compared to a steam-engine in working order. If the engine is to be kept working and in good condition two things are needful—(1), the engineer must repair regularly any tear and wear, the result of the working of the machine, and (2), a regular supply of fuel must be kept up to maintain the steam. The full meaning of the first of these conditions is plain enough; it will help us materially in arriving at a proper understanding of the nature and purpose of food if we consider more fully what the second implies.

The steam-engine, as it stands completed in the engineer's shop, may be a perfect instrument, and yet it will stand motionless and idle, till "the crack o' doom," unless something more be supplied to it. It possesses all the working parts, properly connected together, but it has no motive power. It lacks *the power of doing work*, that is it possesses no **energy**, for "energy" is defined as the power of doing work. How does the steam-engine obtain this power? It obtains it from steam at high pressure. Steam at high pressure possesses energy, energy stored up, so long as the steam is imprisoned in the boiler; but as soon as the steam is allowed to expand into the cylinder against the piston-rod, its energy is liberated, and appears in the form of mechanical movement, in the motion of the piston and the wheels to which it is connected. The energy, or power of doing work, stored up in steam at high pressure becomes transformed into energy liberated, work actually done, in the moving steam-engine as it lifts or transports the load attached to it. Thus we may have energy stored up, or as it is called **potential energy**, the power of doing work not in operation, and we may have energy liberated, **actual energy**, the power of doing work in actual operation. There are many illustrations of this difference between potential or stored energy and actual energy. A water-dam is a store of energy. The dammed-up water has the power of doing work, but so long as it is confined behind its barriers it remains only potential energy. If the gates are raised and the water allowed to flow away, its energy is liberated, and in its course to the sea may turn many mill-wheels, so that the potential energy of the dammed-up water becomes transformed into the actual energy of the mill-stones as they grind the flour. A wound-up clock-spring is another illustration of potential energy. While the spring is held by its catch the energy is stored, but as soon as the spring is permitted slowly to uncoil, its energy is liberated, becomes actual, and appears in the movement of the clock-work. Thus steam at high pressure, a head of water, a coiled spring are all illustrations of energy in the potential condition, capable of becoming changed into actual energy, as soon as the steam is permitted to expand, the water to seek the low level, and the spring to uncoil. The winds are illustrations of actual energy, energy being liberated, actual energy which is utilized by the sails of a ship or the arms of a windmill.

The Sources of Energy.—Now the question arises, where did the energy in each case come from? how does steam or a head of water or a coiled spring come to possess the power of doing work? Take the head of water to begin with. It is plain that its power of doing work is due to its position above the sea-level. As soon as it reaches the sea-level its power of doing work is gone. It is the mass of water in its course downwards to the sea that can do work. It is also plain that the higher the dam is above the sea-level, and the larger the quantity of water collected in it, the more work will be got out of it, the larger and the more numerous may be the mill-wheels which it will turn in its downward course. In short, if the height of the water above the sea-level be known, and the quantity of water in the dam, one could obtain an exact idea of the stored-up energy it represented, and of the amount of work that could be got out of the water in its descent. Suppose two dams, containing each the same quantity of water, but one only half the height above sea-level of the other, the water flowing from the high one would be able to do twice the amount of work done by the water from the low one. In short, the energy of falling water is the same as that of a falling weight, which depends on the amount of the weight and the distance through which it has to fall. The stored-up energy of a head of water may, then, be called potential energy *of position*, and the question, how did the water come to possess energy? will be answered if we can tell how the water came to be so high above the sea-level. The answer is easy. The water is the collected rain which has fallen. And what is the rain? Rain is originally vapour raised from the sea, &c., by the heat of the sun. The warm vapour passing through the atmosphere comes into contact with colder portions, clouds are formed, and finally the vapour is condensed by the cold and falls as rain. Collected in the uplands it

forms a head of water. It is the heat of the sun, then, that raised the water from the sea-level to the height, just as truly as a man may raise a weight from the ground and place it in a high position; and the energy of the head of water is really stored-up energy, which at a previous time had been liberated from the sun. The actual energy of the sun, as it does work in raising water from the ocean as vapour, becomes transformed into the potential energy of the mill-dam, and the potential energy of the mill-dam becomes re-transformed into the actual energy of the falling water as it turns the mill-wheel. When the water reaches the sea—and part of it before that—it may become again raised by the sun's heat in the form of vapour to fall as rain among the hills, and the circle of transformation may go on again. The power of doing work possessed by a head of water is thus derived from the sun. What of the energy of winds? Winds are due to differences of temperature in the air, the differences producing currents in the atmosphere. Take the case of the trade-winds. The sun's rays, beating directly upon the equator, heat enormous masses of air, which rise and flow north and south towards the colder regions of the poles, while colder currents flow in from both sides to the equator, become heated, and in their turn rise and spread outwards above. The energy of wind currents is thus also derived from the sun.

Let us think of the coiled spring, whence is its energy obtained? The spring was coiled by the strength of someone's hand. The person who turned the key expended energy, did work, in the act. But the energy liberated from the muscles of his hand and arm as he turned the key was not lost; it was being stored in the coiling spring, and would again be liberated in keeping the clock-work going. The energy of the person's muscle was derived from food consumed, and we shall see by and by (p. 528) that this energy too is in its origin traceable back to the sun.

Now let us return to the steam-engine; its energy is derived from pressure of steam, but how is the potential energy of steam at high pressure obtained? The steam is raised from water, placed in a boiler over a furnace in which fuel, let us say coal, is burned. It is the heat derived from burning coal that raised the steam so abundantly. So that the mechanical work done by the engine is derived, through pressure of steam, from the energy of heat. It appears, then, so far as the steam-engine is concerned, that the energy it liberates in doing work is derived from coal. The coal is the store of energy, a mass of potential energy, and, in the act of burning, its stored-up energy is liberated and appears, through the medium of the mechanical parts of the engine, as mechanical work. But how does the coal come to be a store of energy—what is coal? Of every pound of coal rather more than $\frac{3}{4}$ths consist of the chemical element called carbon. Now carbon has a strong attraction for oxygen gas, the chief gas in ordinary atmospheric air. When carbon and oxygen unite, there is formed a third substance, which, in ordinary circumstances, is a colourless gas. This union takes place with such force that an enormous quantity of heat is produced. If any two bodies are caused violently to clash together heat is produced by the force of collision. If cold iron be rapidly hammered on an anvil, in a short time it will be perceptibly warm. The particles of carbon having a strong chemical attraction for the particles of oxygen gas, as soon as they get the opportunity they rush together, and the collision of the uniting particles liberates heat. So, at least, we may explain it to our minds. To this process of uniting with oxygen the terms **burning, combustion,** or **oxidation** are applied. If we were to express in scientific terms such an ordinary everyday fact as that "the fire burns," we might say "the coal is undergoing oxidation in the grate." It is not necessary to speak by the card in this way, but it is very necessary to remember that, when the fire burns, what is really happening is that the carbon, of which the coal mainly consists, is uniting with the oxygen contained in the air, with the result that carbonic acid gas, among other products, is formed and escapes up the chimney, and a great amount of heat is given off by the force of the chemical combination. In the case of coal the union with oxygen needs encouragement to begin with, and the needed encouragement is afforded by applying a light to the coal. Once it has made a start it goes on, however, vigorously, provided the supply of oxygen is plentiful, provided, that is, there is plenty of air, and a draft of air to bring fresh supplies to the fire. Everybody knows that, if the chimney "will not draw," the fire goes out, that is, there is not sufficient draft to bring fresh supplies of air (which contains the oxygen) quickly enough to permit the union to go on. If the fire is languishing, someone goes for the bellows and speedily blows the fire into a blaze; that is, by means of the bellows large quantities of oxygen are quickly driven into the fire, and the rate

of chemical combustion is so much increased that the heat becomes very great. It is in this process of union with oxygen, then, or oxidation process, that heat is liberated; and heat is liberated wherever that process occurs. The heat may not be perceptible if the process is slow, but wherever the process is very rapid the heat is great. We are thus enabled to understand that the energy of heat as thus derived is the result of the energy of chemical attraction.

But we have not yet answered fully the question of the source of the energy of coal. How did carbon come to be in the form of coal? Coal is derived from vegetable matter. Beds of coal were originally masses of vegetation, perhaps in some primeval forest. The vegetable matter has become covered over, and, under the influences of temperature, moisture, and pressure, chemical changes have gone on in the slow course of ages, which have resulted in converting the original plants, shrubs, and trees also, it may be, into masses of coal. The carbon, then, of the coal has originally formed part of the structure of a living plant. Now the carbon does not exist in the living plant in the simple form of the chemical element, but built up into highly complex compounds in the form of fats, oils, starches, and sugars. All these are compounds of carbon manufactured or built up by the plant in the course of its life. The plant obtains the carbon, which it thus builds up, from the atmospheric air, in which it exists in the form of the gas we have already mentioned, carbonic acid gas. That gas, we have seen, is a chemical compound of carbon and oxygen, and the plant seizes upon this compound in the air, splits it up, liberates the oxygen, retains the carbon and builds it up in its body into the complex fats, starches, &c. In this building-up process the plant does work, just as a man does work in lifting a weight or coiling a spring, and the energy it thus expends is stored up in its body in the starch or fat it has manufactured, just as a man stores up the energy, expended in lifting the weight or coiling the spring, in the weight he has lifted or the spring he has coiled. The plant, therefore, stores energy in the complex carbon compounds it produces. Where did the plant get the energy to do this? It has been shown that the plant can only separate carbon from the atmosphere and build it up in its own body *under the influence of the sun's rays.* Unless the sun's rays were poured upon it it would cease to do this and die. In the end it comes to this, then, and this is the important point, that the energy of the plant is derived from the sun, and that the energy of the sun's rays is stored up in the plant in the form of fats, oils, sugars, and starches, and such carbon compounds. This stored-up energy becomes, under the influence of temperature, pressure, &c., already referred to, the stored-up energy of coal. When we burn coal we liberate, by the agency of chemical combination, the energy which, countless years before, the plant had stored up from the sun's rays, and, by appropriate means, convert it into the energy of steam at high pressure, and then obtain it as work done in the form of mechanical motion.

Thus we find the energy of a head of water, of currents of air, and of coal, are ultimately derived from the sun, from which source there thus really proceeds practically all the power of doing terrestrial work.

In the case of coal we see a remarkable circle of changes similar to that observed in the case of a head of water. The plant stores the energy of the sun; in time the stored energy reaches us as coal. We burn the coal and liberate the energy. In this act carbonic acid gas is formed and passed into the atmosphere. The plant seizes upon the gas and under the influence of the sun again converts the carbon into a store of energy, to be again liberated, and so on.

Further, we have traced the building up of fats, oils, starches, and sugars in the plant to the energy of the sun. But these form a large portion of man's food, and the exclusive food of animals used by man for food—the ox, sheep, &c. The food of man is then the stored-up energy of the sun, which man takes into his body. In his body he liberates that energy in the form of heat and mechanical work, so that the energy he expends in lifting a weight, coiling a spring, &c., is energy derived originally from the sun.

The Conservation and Transformation of Energy.—In the preceding paragraphs we have had illustrations of the fact, the discovery and proof of which form one of the chief triumphs of modern science, that energy is never lost. When energy seems to disappear, in reality it does not do so; it simply assumes another form. The energy of chemical action may become transformed into the energy of heat, that of heat may assume the form of mechanical work. The energy expended in the form of mechanical work, as in lifting a weight, is not lost, but becomes potential energy of position, for the weight as it descends may do work or liberate heat and so on. Thus we have an idea of what is meant by the modern law of the

conservation of energy, the law which states that energy is never lost, and also of what is meant by the transformation of energy, which explains what takes place when energy seems to disappear. The right understanding of this is of the utmost importance in our study of foods.

The Energy of Heat and of Mechanical Work.—Let us return again to our illustration of the steam-engine. We have seen that the power of doing work possessed by the steam-engine is obtained from the coal in the form of heat. If it is true that energy is never lost, and if we suppose our engine to be a perfect one, so that all the heat given off from the coal is converted into work done by the engine, then the amount of work which the engine can do ought to be exactly measured by the amount of heat given off from the coal. Is this true? Does a certain amount of heat always represent a certain amount of mechanical work, so that given a certain amount of heat, one can calculate from it the amount of mechanical work, assuming that all the energy of heat is converted into work done? There is such a definite relation, and it was proved by two men, working independently of one another, Julius Robert Mayer (1842), a Schwabian physician, and James Prescott Joule (1845–1847), a manufacturer of Manchester. To determine the relationship, it is plain one must have to begin with standards of measurement for heat and work done, just as to determine the weight of any body one must have a standard of weight, namely, the pound weight. The standard measure of heat is the amount of heat necessary to raise the temperature of one pound weight of water at the freezing-point one degree on the Fahrenheit scale. This amount of heat is called the unit of heat, and is called the **calorie**, as the standard of weight is called the pound, or the standard of length the yard. Ten pounds weight of water heated by 1 degree Fahrenheit represent 10 heat units, or 10 calories. The standard of work is the amount of work done in raising a weight of 1 pound 1 foot high. This is the unit of work or the **foot-pound**. When a man raises a weight of 1 stone 1 foot high, he is said to do 14 foot-pounds of work, and if he raises 2 stones (28 pounds) 10 feet high, he does 280 (28 multiplied by 10) foot-pounds of work. Now, the question is, is there any exact relation between the calorie, or unit of heat, and the foot-pound, or unit of work? for if there is, it will be necessary only to measure how many units of heat are given off from the burning of 1 pound of coal to determine how much mechanical work can be got out of the energy thus liberated from the coal. Now, we have said that a man expends energy in raising a weight to a certain height, and the quantity of energy depends on the weight and the height to which he has lifted it; and further, that the energy thus expended is stored up in the weight; when the weight is allowed to fall the energy is liberated. If the weight have a cord attached to it and the cord be wound round some piece of clock-work, the liberated energy will be employed in doing work. If a weight of 10 lbs. be raised 50 feet, then it has stored up in it 500 foot-pounds of energy. Well then, to determine the relation between heat and mechanical work, Joule used an apparatus represented in Fig. 190.

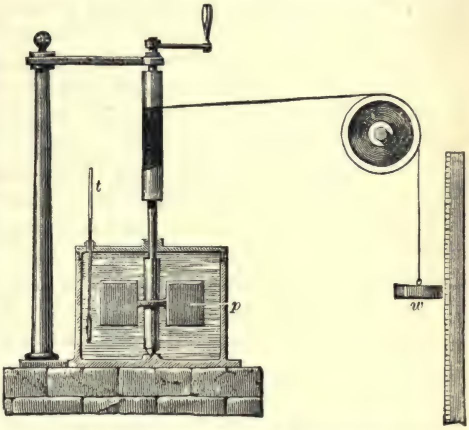


Fig. 190.—Joule's Apparatus for the Determination of the Mechanical Equivalent of Heat.

It consisted of a box in which, fixed to an axle, was a set of eight small paddles (p). The axle projected out of the box and had wound round it a cord, which passed over a drum, and connected to the cord was a certain weight (w). When the weight was allowed to fall, the drum revolved, the axle was turned and with it the paddles in the box. The box contained a weighed quantity of water, the temperature of which was taken. The revolving paddles agitated the water. A thermometer (t) fitted into the box dipped into the water. If the water became warmer the thermometer indicated the amount of heat. Joule allowed the weight to fall, causing the water to be churned, and then he found that, by the churning, the water was warmed. That is to say, the energy liberated by the falling weight, was transformed into the mechanical work of the revolving paddles, and that again was transformed into the energy of heat. Joule found that by a weight of 1 lb.

falling 772 feet, 1 lb. weight of water was raised one degree in temperature. That is to say, 772 units of work, or foot-pounds, were equal to 1 unit of heat or 1 calorie. We have seen that the energy liberated by a weight of 1 lb. falling 772 feet is the same amount of energy as is expended in raising 1 lb. 772 feet high. So that we might put the result thus: the amount of energy which, appearing as heat, will warm 1 lb. of water by 1 degree Fahrenheit, will, if converted into mechanical work, raise 1 lb. weight 772 feet in the air, or, what is the same thing, will raise 772 pounds 1 foot high. This number 772 is, therefore, called the **mechanical equivalent of heat.** In short, 1 unit of heat is equal to 772 units of work. If, then, a certain mass of coal yields 10 heat units, we can tell how much work it represents. Multiply by 772. The energy stored up in the coal, if all converted into mechanical work, will raise 7720 pounds 1 foot high, or 1 pound 7720 feet high. Similarly, if the weight of a ton has been raised 10 feet high, we can tell how much heat that represents. One ton is equal to 2240 pounds. That has been raised 10 feet, so that 22,400 foot-pounds of work have been done. But 772 foot-pounds are equal to 1 heat unit. Therefore 22,400 divided by 772 will give the amount of heat, in heat units, represented by the raising of the ton weight. It is equal to fully 29 heat units.

Here, then, is a means of determining the amount of energy stored up in any substance, such as coal, wood, oil, &c. It is only necessary to burn a given weight of the substance, say 1 pound, and to find how much water the heat produced will warm by 1 degree Fahrenheit. The figure obtained expresses the units of heat, or calories, yielded by the substance, and this, multiplied by 772, gives the mechanical work which the energy stored up in the 1 lb. of substance might perform, *supposing all the heat could be converted into mechanical work.*

Now, various observers have determined by experiments the amount of heat given off from very many different substances, so that there are now ready to one's hands the means of determining the value of these substances for the doing of work. The method by which the results were obtained it will be interesting to note. The instrument used to determine the amount of heat given off by a body in burning is called a **calorimeter**, or measurer of heat. It is represented in Fig. 191. It consists of a small chamber (C) within a much larger one (D). The space between the two chambers is filled with water, the quantity of which is measured. A thermometer (t) dips into the water to indicate the temperature. In the inner chamber is placed the substance to be burned. The heat given off in the process

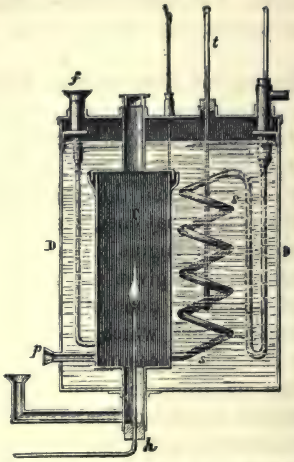


Fig. 191.—Dulong's Calorimeter for Combustion of Gases.
The gas to be burned enters by h, oxygen for combustion by f or p, and the products of combustion pass off by the worm s, s.

of burning is communicated to the water, various careful arrangements being made to prevent it being otherwise lost. When all the substance has been burnt, the temperature of the water is read off, and as the quantity of water is known, the units of heat are readily ascertained. It has been determined by such means that 1 lb. of wood charcoal, if completely burned, will yield 8080 heat units, that is will raise the temperature of 8080 pounds weight of water by 1 degree Fahrenheit. This heat we have seen is the result of the chemical union of the carbon, of which charcoal consists, with oxygen. Now, there is a gas called hydrogen, which, when chemically combined with oxygen, forms water. This gas burns. It is its presence in ordinary coal-gas that makes the gas burn. When hydrogen is burned with a stream of oxygen a flame of most intense heat is produced. It is this flame directed on a cylinder of lime that gives the intense light, the lime-light, so commonly used for magic lanterns. One pound weight of hydrogen when completely burnt yields no less than 34,460 units of heat.

We see, then, what an enormous quantity of heat is given off by carbon and hydrogen, and we have learned how, from the quantity of heat, we can determine the value of these substances for the production of mechanical work. Anyone who thoroughly understands this is provided with the means of estimating the value of different substances used as food-stuffs.

Food as a Store of Energy.—In the previous paragraphs it has been necessary to notice that fats, oils, starches, sugars, are built up by the plant out of chemical elements, which they obtain from the atmosphere and also from the soil. Now these different kinds of food-stuffs all consist of three elements, carbon, hydrogen, and oxygen, but arranged and combined in a highly complex way. We have seen, moreover, that the building up of these elements implies the expenditure of energy, and that the energy expended in the process is stored up in the manufactured substances. If these substances be broken down and reduced to their elementary form, the stored-up energy will be liberated. This breaking down can be effected by the process of oxidation or burning, by which the carbon unites with oxygen to form carbonic acid gas, and the hydrogen unites with oxygen to form water. The oxygen contained within the substances themselves is used for the process, but is not sufficient, and more requires to be supplied from without. In the oxidation process, whether it takes place rapidly or slowly, the stored-up energy is released in the form of heat, and from the quantity of heat liberated can be estimated, in the way already described, the value of the food-stuff for the production of mechanical work. This is true not only of the fats, starches, &c., that may be stored up in a plant, which, from one point of view, may be considered as something apart from the body of the plant itself, but is true also of the tissue of the plant itself, of the living matter or protoplasm of the plant, within which the living processes of the plant are accomplished. The protoplasm or living tissue of plants, as of animals, consists mainly of four elements, the three already named, carbon, hydrogen, and oxygen, and another of infinite importance, nitrogen, along with sulphur and sometimes phosphorus. If a plant be burned, the protoplasm becomes oxidized into carbonic acid gas, and water, and also into ammonia, the ammonia containing all the nitrogen, which had existed in the organized matter of the plant, the oxidation being accompanied as before by the liberation of energy in the form of heat. Animals feed on plants, some of them exclusively, and build up the compounds found in the vegetable food into still more complex substances in their own body, forming thereby muscle, blood, bone, fat and so on. Part of the food is never built up into the body of the animal, but stays in the body only long enough to be broken down into simpler and unorganized bodies, in order that the energy contained within it may be liberated for the use of the animal. Man consumes as food both vegetable and animal structures, uses it partly to build up the structure of his own body, and breaks part of it down into elementary substances in order to obtain from it the stored energy it contains. Food, then, whether animal or vegetable, consists of elementary substances built up into complex forms, and the energy which it thus contains may be liberated as heat by the process of burning. Various experiments, conducted by Professor Frankland, of the Royal School of Mines, and others, have been carried out for the purpose of accurately determining the value of different food-stuffs for mechanical work by the amount of heat liberated from them in process of combustion. The method adopted was that of the calorimeter already described. The following table gives the results obtained by Frankland. It expresses the amount of heat in heat units obtained by completely burning in the calorimeter 1 lb. of each substance named. The food-stuff was employed in its natural condition, that is without previous drying, unless when stated to the contrary.

Name of Food-Stuff.	Heat units per lb.[1]
Cod-liver oil,	9107
Butter,	7264
Cocoa nibs,	6873
Cheese (Cheshire),	4647
Bread-crust,	4459
Oatmeal,	4004
Flour,	3936
Pea-meal,	3936
Arrow-root,	3912
Ground rice,	3813
Yolk of egg,	3423
Lump-sugar,	3348
Commercial grape-sugar,	3277
Hard-boiled egg,	2383
Bread-crumb,	2231
Ham (boiled),	1980
Mackerel,	1789
Beef (lean),	1567
Veal,	1314
Guinness's stout,	1076
Potatoes,	1013
Whiting,	904
Bass's ale,	775
White of egg,	671
Milk,	662
Apples,	660
Carrots,	527
Cabbage,	434

[1] Frankland used the French thermometric scale, the Centigrade scale. To heat 1 lb. of water by 1° on the Centigrade scale requires 1389 units of work, while, as we have seen, 772 is the figure for the Fahrenheit scale. To convert heat units on the Centigrade scale, therefore, *multiply* by 1389, and to convert units of work into heat units on the same scale *divide* by 1389.

By performing the appropriate calculation we might express the value of the energy liberated from each substance in terms of mechanical work. Thus from these figures we find that the total energy liberated from 1 ounce of butter would, if all could be converted into mechanical work, raise 281 tons 1 foot high.[1] Other illustrations are given in the table.

1 ounce of	butter is equal	to	281	tons raised 1 foot.
,,	oatmeal	,,	152	,,
,,	beaf (lean)	,,	55	,,
,,	milk	,,	24	,,
,,	carrots	,,	20	,,
,,	cabbage	,,	16	,,
	&c.		&c.	

If one carefully examines this list, one or two points of great interest speedily reveal themselves. The first glance shows that fats and oils head the list, they yield the greatest amount of energy. Cocoa nibs rank very high; but when we examine the composition of cocoa nibs we find they contain 50 per cent of fat, so that it is really because of their contained fat that they have so great value as stores of energy. Next to the fatty substances come the starchy. Arrowroot consists mainly of starchy material, while flour consists of starch to the extent of nearly 75 per cent, and meal to 63 per cent. If we ask how oatmeal has a higher value than flour or arrow-root, the answer is that oatmeal contains also 10 per cent of fat, while flour contains less than 1 per cent, and arrow-root contains none. It is, then, the fat in oatmeal that causes it to rank above flour, &c., as a store of energy. Again look at the difference between yolk of egg alone and the whole egg in the amount of energy they yield. Here again it is a question of fat. In the yolk of egg there is 30 per cent of fat, but when one takes white and yolk mixed, as the white contains no fat, the percentage of fat in the whole is reduced to 11. Thus 1 lb. of yolk is of more value, as a store of energy, than 1 lb. of mixed white and yolk. It is a similar circumstance that gives to mackerel a higher value as a store of energy than is possessed by whiting. Mackerel contains fully four times the quantity of fat that whiting does. Thus the list shows that, regarding food-stuffs as stores of energy, fats take the highest rank, starchy and sugary food-stuffs come next, and meaty substances (lean beef), &c., are poorer in the amount of energy they yield than either. This has been further shown by the results of actual experiments on dogs, in which it was found that

100 parts of fat yielded as much heat and energy for work as
232 ,, ,, starch,
234 ,, ,, cane-sugar,
and 243 ,, ,, lean meat.

Is there any reason for this high value of fat as a source of energy? When fat is analysed it is found that of every 100 parts

79 consist of carbon, and
11 ,, of hydrogen

and only 10 of oxygen. That is 90 of the 100 parts are combustible or oxidizable substances. Starch, on the other hand, contains in every 100

45 parts of carbon and
6 ,, of hydrogen,

a total of 51 parts only of combustible substance, the remaining 49 consisting of oxygen with which the burning is partly effected. Sugar consists of

43 parts carbon, and
6 ,, hydrogen

in the hundred, a total of 49. The enormous quantity of heat liberated by the burning of carbon and hydrogen has been already indicated (on p. 530), and when we find fat containing 90 parts in 100 of these elements as against 51 in starch and 49 in sugar, the reason of the high value of fat as a source of energy is apparent.

Now it will naturally occur to everyone, who considers the figures that have been given, that the amount of energy represented as mechanical work given off, from the burning of the food-stuffs named, is too great for belief. It seems absurd to think that 1 ounce of butter will yield heat, which, if transformed into work done, will raise 281 tons 1 foot high. The amount of heat stated is actually given off, and has been determined, as stated, by actual experiments in the calorimeter. In estimating the mechanical work that heat represents, it has been assumed that *all the heat is transformed into mechanical work*. But, as a matter of fact, no engine has been devised, or can be devised, capable of utilizing all the heat obtained from the burning of the fuel, and converting it into mechanical work. In the most perfect machine yet constructed it has been found possible to convert

[1] 1 lb. of butter gives 7264 heat units. To get the equivalent in mechanical work, multiply by 1389. The result is 10,089,696 in foot-pounds per *pound* of butter. That is equal to 630,606 foot-pounds per *ounce* of butter. 630,606 divided by 112 expresses the same amount in hundredweights, namely 5630; and that again divided by 20, expresses the amount in foot-tons, namely 281.

only ⅙th part of the heat into work. It is the aim of engineers to construct engines that will utilize as much of the heat as possible, and yet this is the best result they have obtained. They do not wish the engine to become heated, for that means wasting the energy of the fuel. In the animal body the energy derived from food is converted into mechanical work to a much greater extent than can be effected by any steam-engine. It has been estimated, for example, that the horse can transform 32 per cent of the energy obtained from food into work, that the ox can transform 43 per cent, and man can transform 53 per cent. So that in this respect the human body is far ahead of the most perfect engine that man has yet been able to construct. But, in the case of the animal body, the energy of food that appears as heat, and is not transformed into work, is not lost. It is necessary to heat the animal body and to maintain its warmth at a certain degree, which is usually higher considerably than that of the external temperature. Because the body is continually in contact with an atmosphere colder than itself, a large quantity of heat is continually being given off from the body. Heat is constantly being lost in the evaporation of the sweat, in heating the air given out from the lungs, in heating the discharges from the body, &c. The quantity of energy consumed in this way, in 24 hours, has been calculated as equal to 2,839,000 units of heat, or a heat sufficient to raise about 62 pounds of water from freezing-point to boiling point (Gamgee). But energy is not only being constantly expended in the body in this way, it is also being expended in large amount in doing work of which there is no external sign. The heart is regularly contracting, driving the blood through the body. The work it does "might be estimated without exaggeration as at least equal in 24 hours to the work expended in lifting 120 tons to the height of 1 foot, while almost certainly it would greatly exceed this estimate. That is to say, that the heart of a person, who is almost absolutely at rest, does an amount of work which is a sensible fraction of the *external*, or, to use a popular expression, the *manual* labour performed in the working day of a hard working labourer." Over and above this, there is the work being regularly done by the muscles of respiration in expanding the chest against considerable resistance. If all these things are taken into account, it will become apparent that there will not be left over a very large balance of energy derived from the food for the performance of external work. Moreover, one must not forget that when a man simply walks about he is transporting the weight of his body, and when he walks up a stair he is raising the weight of his body so many feet into the air. Thus a man weighing 11 stones (154 lbs.) going up a step 6 inches high, does 77 foot-pounds of work in carrying up his body, and if he goes up a stair of 12 steps 20 times a day, in this exercise alone he does 16 foot-tons of work. The same man in walking one mile does nearly 17⅘ foot-tons of work in the mere transporting of his own weight.

All this time we have been arguing from figures derived from the burning of food-stuffs in the calorimeter. It is time now to say that it appears that food-stuffs undergo a precisely similar change in passing through the body to that they undergo in the calorimeter. The change, that is the combustion or oxidation process, as carried on in the calorimeter, is very much more rapid than the change as accomplished in the body, but the results are the same. Fats, starches, and sugars, are burnt to carbonic acid gas and water in the body, just as they are outside of the body, and the carbonic acid gas and water are, thereafter, expelled from the body as waste products. Whether the process be rapid or slow, the total energy liberated, when the process has been completed, is the same. The figures derived from the calorimeter may, therefore, with perfect propriety, be applied to the human body. There is an exception. Meat does not undergo complete combustion in the body. The figures obtained from the experiments are, in consequence, too high for it. Corrections for this are, however, easily made. This it is not necessary for us further to consider.

Now we must return once more to the illustration with which this section opened. We said the human body could be compared to a steam-engine in thorough working order, and that to maintain it in good condition it was necessary (1) for the tear and wear of its parts to be maintained, and (2) for energy to be imparted to it for the doing of work. We have seen that the energy is derived from the combustion of coal in its furnace. This induced us to consider the nature and sources of energy, and we naturally went on to consider food as a source of energy to the human machine, for the human body may also be viewed as a machine for doing work. In the doing of work some of its parts are subject to tear and wear, which, if the human machine is to be kept in good working order—that is, in good health—must be speedily re-

paired. In the second place, it must be supplied with energy.

This, then, is the twofold business of food, (1) to repair the tear and wear of the human machine, and (2) to yield energy by which it may do its daily work. Having seen, generally, how food is fitted to yield energy, we must next notice how food is fitted to repair tear and wear. Suppose a steam-crane is engaged lifting heavy loads for an hour on end. During the process two things have happened; (1) steam has been allowed to escape from the boiler into the cylinder to work the piston—that is, energy has been liberated, and to a slight extent—a very slight extent—the working parts of the machine have been worn. The energy for lifting the weight has not been obtained from the wear and tear of the machine, but from the steam. Now substitute a man for the steam-engine, and suppose him to work for an hour on end wielding a heavy hammer. He has lifted the hammer regularly by the repeated contractions of some of the muscles of his arm, and in these muscles two things have happened; (1) energy has been liberated within the muscles by the combustion or oxidation or burning of some substance contained in the muscles, and (2) the muscles, to a slight extent—a very slight extent—have been worn. That is to say, while the muscles have actually suffered some wear and tear by this work, the energy liberated in the muscles need not have been produced by the breaking down of some of the actual fibres of the muscle, but only of some substance contained within the muscle. It is plain, then, that there may be some considerable difference between supplying the material out of which energy is obtained and the material out of which the wear of the muscle is repaired. Whether there be any difference or not, there is only one source from which both kinds of material are obtained, and that source is food supplied. It is also perfectly plain that if the food supplied is to be sufficient for the rebuilding of wasted muscle, it must contain all the materials of which muscle is found to consist. The same is true of every other part of the body. In the working of the bodily machine the bones suffer some tear and wear. It may be slight, but the wear and tear, nevertheless, occur, and the food supplied must contain the elements of which bones are made. Nerves suffer waste, and every tissue of the body; and thus food must contain all the elements of which every organ and tissue of the body are built up. If it does not, some tissue of the body will not be supplied with material for repairing its wasted portions, and a catastrophe will, sooner or later, occur. In order to understand what kind of food is fitted for such purposes, we must, therefore, have some kind of knowledge of the composition of the human body.

THE CHEMICAL COMPOSITION OF THE HUMAN BODY.

Chemical Elements found in the body.—All the various complex substances found in nature can be reduced by chemical analysis to simple substances, and when they have been reduced to their simplest forms and cannot be any further split up, there remain seventy elements. By combinations of these seventy elements, of various kinds and in various proportions, all the substances known to exist in the world of nature are built up.

A human body, when dead, may be submitted to chemical examination just as a handful of earth, a piece of rock, or any other substance may be. When that has been done it is found that blood, muscle, nerve, bone, skin, hair, teeth, &c., may also be reduced to similar elements—that, in fact, the human body is built up of a few of the same seventy elements that are found in nature. Of the seventy elements only fourteen are found in the human body, namely, **oxygen, hydrogen, nitrogen, chlorine, fluorine, carbon, phosphorus, sulphur, silicon, calcium, potassium, sodium, magnesium,** and **iron.** Some of these elements, as they exist in their elementary form, are gases, others are metals, while the remainder are non-metals. This may be shown as follows:—

Elements found to exist in the Human Body.

Oxygen Hydrogen Nitrogen Chlorine Fluorine.	Gases.
Calcium Potassium Sodium Magnesium Iron	Metals.
Carbon Phosphorus Sulphur Silicon	Non-Metals.

Besides these, excessively minute quantities of other elements, such as manganese, copper, lead, &c., have been found, but probably they are only accidentally or temporarily present, and did not enter into the actual constitution

of the body. They may, therefore, be neglected. Silicon is in a similar position though it appears on the list.

It is interesting to note the proportion in which these various elements are present, and that is shown in percentages in the following table:—

Oxygen ...	... ...	62·430 per cent.
Carbon ...	... ...	21·150 ,,
Hydrogen	... ...	9·865 ,,
Nitrogen	... ...	3·100 ,,
Calcium	... ...	1·900 ,,
Phosphorus	... ...	0·946 ,,
Potassium	... ...	0·230 ,,
Sulphur ...	... ...	0·162 ,,
Chlorine	... ...	0·081 ,,
Sodium ...	... ...	0·081 ,,
Magnesium	... ...	0·027 ,,
Iron ...	... ...	0·014 ,,
Fluorine	... ...	0·014 ,,
		100·000

Oxygen, hydrogen, and nitrogen, as we see from the preceding table, are gases in their uncombined state, and yet they form three-fourths of the weight of the whole human body. Carbon is a solid. Charcoal, lampblack, black-lead, are impure forms of it. It forms more than a fifth of the whole weight of the body. Carbon and the three gases named thus form over 96 per cent of the total weight of the body.

Chemical Compounds found in the body.—It is necessary very carefully to note that, with slight exceptions, none of these elements exist *in their elementary form* in the body; they are combined with one another in various ways and proportions to build up more or less complex substances, differing widely from the elements of which they consist. The slight exceptions are oxygen, hydrogen, and nitrogen. Though the bulk of all three exists in combinations of various kinds, yet a small quantity of oxygen exists uncombined, but in solution, in the blood, a small quantity of nitrogen is also found in solution in the blood, and small quantities of all three exist free in the intestinal canal.

Water.—Now oxygen and hydrogen unite to form water; and water is found in the human body to the extent of over 60 per cent.

Inorganic Salts.—Further, a large number of the elements named are found uniting with one another to form inorganic salts, salts found existing in nature, which do not need the agency of any living thing, any organized structure, to cause them to combine, but do so simply by the force of chemical affinity.

The best example of this kind of compound is common salt, a compound of sodium and chlorine, called, therefore, in chemical language, chloride of sodium. It is found in all the tissues and fluids of the body, and is one of the most important inorganic substances the body contains, and is absolutely necessary for continued existence.

Chlorine, besides uniting with sodium, forms a salt in conjunction with potassium, the chloride of potassium, and forms, with nitrogen and hydrogen, the chloride of ammonium, ammonia being a compound of nitrogen and hydrogen. These are found in the body.

Other salts are found in the body, of great importance being those formed by a combination of phosphorus with sodium, with potassium, with calcium, and with magnesium, forming the phosphate of sodium, phosphate of potassium, phosphate of magnesium, and phosphate of calcium (phosphate of lime). This last, phosphate of calcium (that is, phosphate of lime), is the most abundant of the salts of the body. It forms more than half of the bones, and is found in considerable quantity in teeth, and it exists in other solids and in fluids of the body. It is present in milk to the extent of 2½ per cent. Associated with it in bones and teeth is a compound of calcium with carbon and oxygen, carbonate of lime.

Sodium combined with carbon and oxygen exists in the body as carbonate of sodium, and with sulphur and oxygen as sulphate of sodium.

Potassium also exists as sulphate of potassium.

Fluorine and calcium are found united as fluoride of calcium in the bones and teeth, though in very small amount.

If all these compounds, forming salts or mineral matters, that exist in the body, be summed up together, they are found to constitute about six per cent of the whole body weight.

Thus, so far as we have gone, we see the human body consists of:—

Water about	... ...	61 per cent.
Salts or Mineral Matters	...	6 ,,

Namely—*Chloride of Sodium.*
„ of Potassium.
„ of Magnesium.
„ of Ammonium.
Phosphate of Lime.
„ of Sodium.
„ of Potassium.
„ of Magnesium.
Carbonate of Lime.
„ of Sodium.
Sulphate of Potassium.
„ of Sodium.
Fluoride of Calcium.

A compound of hydrogen and chlorine, hydrochloric acid, is found existing as such in the digestive juice of the stomach.

Organic Compounds.—Now, over and above these substances, there exists in the human body a series of compounds not found in the lifeless or inorganic world, substances formed of the union of the same elements that have been named, but which require for their compounding the agency of living structures. For that reason these compounds are called **organic.** Moreover, man and the lower animals cannot compound them, or build them up from the elements. That is done by plants. Man and the lower animals take the organic materials they require from the vegetable world, and so the structure of the animal kingdom, including man as the most imposing portion of the edifice, rests upon the vegetable kingdom as its foundation. The organic materials which animals and men take from the vegetable kingdom they build up into still more highly organized forms in their own bodies.

The organic materials found in the human body fall principally into three classes:—

Proteid or Albuminous Substances.
Carbo-hydrates (that is, Starches, Sugars, and Gums).
Fats.

The elements built up into proteids are carbon, hydrogen, oxygen, and nitrogen, with sulphur; the elements built up into carbo-hydrates are carbon, hydrogen, and oxygen; the elements built up into fats are also carbon, hydrogen, and oxygen. The important distinction between the first and the other two classes is that proteids contain the element nitrogen which the others want. Proteids are, therefore, called **nitrogenous,** and the others **non-nitrogenous** substances.

Further it will be noted that both the carbo-hydrates and the fats are built up of the same three elements, carbon, hydrogen, and oxygen. Though formed of the same three elements, these two classes differ markedly from one another. The difference between the two consists, for one thing, in the very widely different proportions in which the elements are combined in the two kinds of food-stuffs, a difference which chemistry can reduce to figures. But it also consists in the manner in which the elements are combined, just as stone, wood, and lime may be built up into two houses of very different form, and not the least resembling one another. It may now be convenient to put in tabular form the knowledge thus far gained.

The human body contains thirteen elements built up into various compounds, as follows:—

Inorganic—

		Built up of
	Water	Hydrogen and Oxygen.
	Salts	Hydrogen, Oxygen, Nitrogen, Carbon, Calcium, Phosphorus, Potassium, Sodium, Sulphur, Chlorine, Magnesium, Iron, Fluorine.

Organic—

Nitrogenous	.........Proteids ...	Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur.
Non-nitrogenous	Carbo-hydrates	Carbon, Hydrogen, Oxygen.
	Fats	Carbon, Hydrogen, Oxygen.

We must consider the organic substances for a little.

Proteids consist, as already mentioned, of carbon, hydrogen, oxygen, nitrogen, and sulphur. The type of proteids is egg albumin, white of egg. These proteid or albuminous bodies are found in muscle, in nerve, in glands, in blood, and in nearly all the fluids of the body. The albuminous body of muscle is called **myosin,** that of the fluid part of blood is **serum-albumin,** that of coagulated blood is **fibrin,** the red corpuscles of the blood are formed of **hæmoglobin**, which contains an albuminous body.

Milk contains two albuminous bodies, the chief of which is **casein,** which forms the curd, and is the main constituent of cheese. Proteid bodies occur in various forms in vegetable structures; the proteid of cereals, wheat, corn, &c., is called **glutin,** that of peas is **legumin.**

Other forms of proteids exist. Thus, in bones, and connective tissues like tendon and skin, a proteid body exists which, on boiling, yields **gelatin.** Gristle (cartilage, p. 23) yields another proteid called **chondrin.**

Of proteid substances a human body is estimated to yield on an average about 18 per cent.

Carbo-hydrates are formed of carbon, hydrogen, and oxygen, the last two being in proportions to form water. Starch is a carbo-

hydrate, and is found in the body in the form of **glycogen** or animal starch, supposed to be formed by the liver (see p. 147). Sugar is another of this class, and is found as **grape-sugar** in blood and liver, **muscle-sugar** or **inosite** in muscle, and **lactose** or **milk-sugar** in milk.

This class exists largely in the vegetable kingdom. Thus potatoes, rice, sago, &c., consist largely of starch. Sugar is found in fruit as **laevulose**: there is **grape-sugar**, of which honey mainly consists, derived from the sweet juices of fruits and flowers, and **cane-sugar**. **Gum** and **cellulose**, obtained from plants, are also carbo-hydrates.

The carbo-hydrates in the body are estimated at a fraction of one per cent of the total body weight.

Fats are formed of carbon, hydrogen, and oxygen, in which the two latter are not in proportions to form water. There are three kinds of fat in the body—**stearin**, of which ordinary tallow candles are made, **olein**, the chief ingredient of olive-oil, and **palmitin**. The fat of the human body consists of a mixture of these three, and is liquid at the ordinary temperature, the olein keeping the other two in solution.

The body of an average man contains about 16 per cent of fats.

Now, while it is said that a human body consists of so much water, so much salts, so much proteid material, so much carbo-hydrates, and so much fat, it is not to be supposed that these exist in a condition easily separable from one another.

Take a piece of the red flesh (muscle), it does not only contain proteids but also water, salts, carbo-hydrates, and fats. They are blended or mixed together, as it were, in the muscle, and in different cases the amount will vary. Fat exists in the muscle even though it be not visible to the naked eye; the microscope will show minute fat cells (see p. 17) between and among the muscular fibres.

It requires to be noted that, though the proteids are the principal kind of nitrogenous substances existing in the body, they are not the only ones.

The ferments concerned in digestion, the ptyalin of the saliva (see p. 143), the pepsin of the stomach juices (see p. 143), &c., are nitrogenous also. The colouring matters of the body, that of the blood and red flesh, and those of the bile are also nitrogenous substances. Moreover, as a result of the tear and wear of the body, and the consequent breaking down of the tissues that constantly goes on, a variety of substances is formed from proteids also containing nitrogen. Thus there can be extracted from ordinary red flesh, by means of water, a variety of nitrogenous substances, of which kreatin, kreatinin, sarcin, are the names of some. On this account they are called **extractives**. It is the presence of some of these that gives to flesh its peculiar flavour. Two other important substances produced from the breaking down of nitrogenous substances, and containing nitrogen, are urea and uric acid, found in the urine. Though found in the body, they are to be regarded as unavoidable rather than necessary constituents, since they are the result of tear and wear. In nerve tissues, as another example, are found substances called protagon, cerebrin, &c., supposed to result from nervous activity, which are also nitrogenous. In the same way the changes undergone by sugars, fats, &c., in the body, produce a series of substances that need not be named here. Though constantly found, they are not essential constituents of the body.

Briefly, then, we may put the matter thus, the human body is composed of thirteen elements, built up into compounds. The compounds may be grouped into the following classes—water, salts, proteids, carbo-hydrates, and fats. These five classes of compounds, existing as such in the body, are called the **proximate principles** of the body, and the proportion in which they exist is summarized in the following table:—

Percentages of Proximate Principles in the Body.

Water, ...	61·0	per cent.
Salts, or mineral matters,...	5·5	,,
Proteids, ...	18·0	,,
Carbo-hydrates, ...	0·1	,,
Fats, ...	15·4	,,
Total, ...	100·0	,,

Or we might put it thus:—

The body of a man weighing 148 pounds will contain of

Water, ...	90·0	pounds.
Salts, ...	8·3	,,
Proteids, ...	26·6	,,
Carbo-hydrates, ...	0·1	,,
Fats, ...	23·0	,,
Total, ...	148·0	,,

THE NATURE AND CHEMICAL COMPOSITION OF FOOD-STUFFS.

In the paragraphs in which we have considered the constitution of the human body, we

have really laid down the elementary conditions which all food-stuffs must fulfil if they are fitted to maintain the body in a healthy condition as a good working machine. We may now state these elementary conditions in as brief a manner as possible:

1. Food-stuffs must contain all the elements found built up into the various organs and tissues of the body, else they will not be sufficient to repair the waste going on in the body.

2. These elements are thirteen in number, chief among them being carbon, hydrogen, oxygen, and nitrogen.

3. The animal body cannot make use of these substances in their elementary form. The elements must be built up into compounds, more or less complex.

4. The elements are built up first by the agency of plants, acting under the influence of the sun's rays. The lower animals, used by man as food, consume plants, and build up the materials they contain into still more complex bodies. Then man uses both plants and animals as food, and builds up what they supply into the material, blood, bone, flesh, nerve, skin, &c., of his own body.

The Classification of Food-stuffs.—On page 536 it has been stated that all the tissues of the body, and nearly all the fluids, contain proteid substances in their composition, and that proteids, besides carbon, hydrogen, and oxygen, contain *as an essential element, nitrogen.* No food-stuff, therefore, which fails to contain nitrogen can be sufficient for repairing the tear and wear of the bodily machine. Besides, it has been pointed out (p. 530) that carbon and hydrogen yield, when burnt, enormous quantities of heat, that is to say, liberate large quantities of energy. So that food-stuffs, which consist mainly of carbon and hydrogen, and which contain no nitrogen, while quite insufficient for repairing wasted portions of the body, are most valuable for yielding to the body the energy for the performance of its work. Here, at once, we are provided with a principle of classifying the food-stuffs obtained from the vegetable and animal kingdom. Applying this principle we divide food-stuffs into

NITROGEN-CONTAINING or NITROGENOUS,	to which belong	**Proteids**	necessary for repairing tear and wear of the body.

and

CARBONACEOUS or NON-NITROGENOUS,	to which belong	**Sugars,** **Starches,** **Gums,** **Fats,**	specially valuable for the liberation of energy for work.

We must avoid the mistake, however, of supposing that nitrogenous food-stuffs are only useful for repairing tear and wear, and are always built up into the substance of the body. They contain, as we have seen, carbon and hydrogen, as well as nitrogen, and may thus be consumed in the body solely for yielding energy, without having previously been transformed into any of the living tissue of the body, muscles or bone or nerve, &c. All we assert is that muscle, bone, nerve, blood, &c., cannot be formed without them, since they only of food-stuffs contain the necessary element, nitrogen. This does not imply that they are always so built up. A quantity of proteid food may be eaten greater than is necessary to repair the tear and wear. In such a case the excess will undergo combustion in the body and will thus yield energy. Similarly we must not suppose that carbonaceous foods are used simply to yield energy, and are never built up in the body. For we have seen that the body contains a proportion of such compounds, and as they will also undergo waste they must be renewed from the food. What we do assert is that such substances yield energy in largest amount, and are the most useful forms of food material for the doing of work.

When we are reminded that the human body consists to a large extent of water, and to a small extent also of saline material or mineral substances, the necessity of these being present in food-stuffs is apparent. Thus the food-stuffs needed by man fall into the same five classes of compounds as the substances forming his body (p. 536). They are called the **proximate principles of food, or alimentary principles,** namely:

Inorganic	1. Water.		
	2. Salines or Mineral Matters.		
Organic	3. Nitrogen-containing or Nitrogenous.	Proteids	
	4. Carbonaceous or Non-nitrogenous.	Carbo-hydrates	Sugars. Starches. Gums.
		Fats	

The Fate of Various Food-stuffs in the body.—It may not be uninteresting to state a few of the reasons which have led to the general conclusions that have been indicated. A brief

consideration of the grounds of the conclusions will help to give a better appreciation of the relative value of the different foods, will supply the reasons for varying the kind of food taken under different circumstances, and will afford a more connected idea of the ultimate fate of the different foods in the body.

The Use of Water.—Regarding water not much more need be said. It undergoes no transformation in the body, we may say. But when we consider that the body loses daily about 10 ounces of water in the form of vapour given out in the breath, about 2 lbs. weight daily in the form of sweat from the skin, and from 50 to 60 ounces daily in the form of water given off from the kidneys, the need of replacing that loss is apparent. We shall see that all our food-stuffs contain a proportion of water in their composition, some of them consisting of water to the extent of three-fourths, and thus we are restoring water to the body with every bite we eat, as well as by the water we drink as such, or in beverages such as tea, coffee, &c.

The Use of Salines.—Salts of various kinds are also given off from the body in the perspiration (p. 309), in the excretion of the kidney, &c. (see p. 292), and they must be restored to the body.

The most familiar of the mineral substances we use in our food is common salt, or chloride of sodium (see p. 535). We know how wanting in pleasurable taste are most food-stuffs which are deficient in common salt, and how freely we add it to our food. There are, however, other saline substances always present in food-stuffs which are equally essential to the bodily well-being, though not required to the same amount. The process used in preserving food by pickling removes a considerable proportion of such saline substances from the food. If such preserved food forms nearly the exclusive diet for any length of time, serious effects on the health of the persons are produced. It is in such circumstances that scurvy appears among ships' crews. That this state of bad health is the result of the absence from the food of certain mineral substances is plain from the fact that if fresh vegetables, which are rich in the salines, be freely supplied, or in their absence other substances containing the salts, such as lime-juice, restoration of health results. A definite proportion, then, of saline substances in the food, seems necessary for the proper performance of the nutritive processes in the body.

The Use of Proteids.—The fate of proteids in the body was for a long time the subject of controversy. Liebig's view was that proteids were built up into the tissues of the body, into the flesh of muscle, &c.; and that when work was done it was done at the expense of the muscles, parts of which were broken down or underwent waste by the exertion, and thus proteid food was needed to repair this waste. If this were so it would imply that with increased work there would be increased waste of tissue and need for increased supplies of proteid foods, such as beef, fish, &c. It is extremely interesting to follow the steps by which the accuracy of this view was tested. Proteids, we have seen, are nitrogen-containing substances. If work is done at the expense of proteids then the nitrogenous waste of the body will be increased. Now, practically the only channel by which nitrogenous waste is expelled from the body is the kidneys, and it is expelled in the form of the nitrogenous body urea, the chief ingredient of the urine. If, then, work is done at the expense of proteids, at the expense of the tissues of the body, with increased work there will be an increased amount of urea expelled by the kidneys, and with less work there will be less urea expelled. In fact, the amount of urea expelled will depend on the amount of work done. This has been found not to be the case. Two German professors, named Fick and Wislicenus, made a direct experiment upon themselves. They ascended a mountain, 6561 feet high, and estimated the quantity of nitrogen given off as urea from the body during the period of their exertion, and they compared the quantity with the amount of urea given off from the body before the ascent began and after it was ended. In order not to cause errors by the kind of food taken, they ate no nitrogen-containing food for a whole day before the ascent, nor indeed any food of this kind till after the ascent was over, when they rested and took a liberal meal of meat, &c. The following is the result in the case of Fick:—

Before the ascent,	9·7	grains	nitrogen	per hour.
During ,,	6·3	,,	,,	,,
After ,,	6·1	,,	,,	,,
During the night,	6·9	,,	,,	,,

This shows that the work was not done at the expense of the tissues, else the quantity of nitrogen given off from the body would have increased. The fall in the quantity of nitrogen was due to the abstinence from nitrogenous food, and the increase during the night was in conse-

quence of the meal containing nitrogen taken after the ascent.

This result has been abundantly corroborated by later experiments. Thus, a set of observations was made on a watchmaker in the Physiological Laboratory of Munich, who was placed under three conditions. In one of the observations he received for a time no food and did no work, in a second he received a liberal diet and did no work, and in a third he received a liberal diet and did hard work. The quantity of nitrogen in the food given was estimated, and the quantity given off from the body was noted. If the quantity given off exceeded that of the food, it meant waste of tissues, loss of flesh, and the amount of flesh lost could be calculated from the excess of nitrogen expelled from the body. If as much nitrogen was not expelled as was given in the food, the conclusion was that the balance had been built up in the body, that is, the man had gained flesh, and the gain could also be calculated. Fat is very rich in carbon, and from the quantity of carbon given in the food, and the quantity given out as carbonic acid in the breath, it could be decided whether the body had gained or lost carbon. If the quantity given out exceeded that introduced as food, it was interpreted to mean that some of the stored-up fat of the body had been consumed and the man had lost fat. If the quantity given off were less, it meant that some had been stored as fat, and the man had gained in fat. The results were as follows:—

During the period of—

No food and no work the man lost 11 ounces of flesh and 7⅜ ounces fat,

Liberal diet, no work, the man gained no flesh, but 2¼ ounces fat,

Liberal diet, hard work, the man lost no flesh, but 2 ounces fat.

Work is, therefore, not done at the expense of the built-up tissues, but at the expense of carbonaceous compounds stored up, specially fat, but also carbo-hydrates, such as starch and sugar.

It appears, then, that a certain amount of tear and wear of the tissues goes on irrespective of what amount of work is done, and that this amount is not materially increased with increased work, even with hard work, so that if a certain quantity of proteid food is given per day, sufficient to repair the waste, all that is further needed is a quantity of energy-yielding food, such as fat, starch, and sugar, which should be varied according to the work done, that is, the energy expended.

Supposing more proteid food is given than is necessary to repair tear and wear of tissues, what happens to it? The excess undergoes direct combustion in the body without previous building up into tissue, and thus will yield energy and heat. It appears that some of the excess may even be transformed into, and stored up as, fat. For proteids consist, as we have seen (p. 536), of nitrogen with carbon, hydrogen, and oxygen. When proteid has been consumed in the body, the waste, as we have said, is urea, and the urea contains all the nitrogen that was present in the proteid, but it does not contain all the carbon or hydrogen. Two-thirds of the carbon and hydrogen do not appear with the expelled urea. It seems, then, that, in the body, when proteid is consumed or undergoes combustion, it splits up into two parts, one containing all the nitrogen and a third of the carbon and hydrogen, which is expelled as urea, and another part containing the remaining two-thirds carbon and hydrogen. If this remainder be not immediately consumed to yield heat and energy, it is surmised that it may be built up in the body and stored as a carbonaceous body, such as fat, or a carbohydrate, like glycogen (see p. 147). Thus dogs fed on lean meat may gain in weight by the laying on of fat, derived, therefore, from the proteid of the meat, since fat is not present to any extent in the diet.

It is of great importance to note further that if proteids are necessary for the repair of waste in the tissues, they are equally necessary for the building up of new tissues, as in the growing person, for the production of blood, the growth of muscle, bone, nerve, &c. So that, if an adult man needs only the quantity of proteid that will repair the wear of his tissues, which is not materially increased by his work, a child needs not only sufficient to repair the daily tear and wear, but also an added quantity for growth. *The child needs, then, a larger quantity of proteid in proportion than a full-grown person.* It is because this fact is not recognized that children are fed so largely on non-nitrogenous foods, starchy foods, such as arrow-root, corn-flour, &c. They thus fail to obtain enough nitrogen for the building up of new tissues, and are white-faced from deficient blood, have soft, flabby muscles, and weak, yielding bones.

The Use of Fats.—If experiments show that work is not done at the expense of the nitrogenous tissues of the body, they equally plainly show that it is done at the expense of fats and carbo-hydrates. The waste products of the

combustion in the body of fats, starches, and sugars are carbonic acid gas and water, just as urea is the special waste product of the combustion of proteids. While the amount of urea is not increased by work, the amount of carbonic acid gas given off from the lungs is markedly increased. In the case of the watchmaker, already referred to, while the quantity of urea expelled was the same during the day of hard work as during the day of no work, the amount of carbonic acid gas expelled increased from 14,000 grains on the day of no work to 18,000 grains on the day of hard work. Moreover, if the body be in a cold atmosphere, the amount of carbonic acid given off again markedly increases, indicating an increased combustion of fats and carbo-hydrates to yield heat for the maintenance of the warmth of the body. For a similar reason fat is one of the chief articles of consumption in the Arctic regions. During starvation the fats laid down in the body are the first to disappear. It thus becomes certain that fats are consumed in the body for the purpose of yielding energy for work, and heat for maintaining bodily warmth; and they are, above all kinds of food, best fitted for such purposes. If an amount of fat is given in excess of what is required for these purposes, it is stored up in the body as fat, waiting till called for.

The Use of Carbo-hydrates (sugars, &c.).—As has been already indicated in the paragraph on Fats, the sugars and starches introduced as food undergo combustion in the body for liberating energy and heat, but they are less useful than fats for these purposes, and the explanation of that fact is given on p. 532. These kinds of food-stuffs may be stored up in the body, if not immediately needed, in the form of animal starch or glycogen, which is manufactured and stored in the liver, as explained on p. 147. Thus Dr. Pavy showed by a series of experiments, conducted on dogs, that by a diet of starch and sugar the size of the liver was greatly increased, and that the increase in size was due to the increased quantity of glycogen produced in it from the starch and sugar. It is possible that subsequently this glycogen, before being consumed in the body, undergoes a further conversion into fat. It has been certainly proved that sugars and starches become transformed into fat in the body, and, if not immediately required, are stored up as such. Thus two observers, Gilbert and Lawes, fattened pigs on a diet rich in carbo-hydrates and found that 472 parts of fat were laid down in the body for every 100 parts of fat contained in the food. The increase in the fat could have been effected only by a transformation of the starch and sugar of the food into fat. The wax of bees is a fatty substance, and Huber showed that bees produced wax when supplied with nothing but sugar. Then the delicacy known as *pâté de foie gras* is made from the fatty livers of geese. The fatty degeneration of the liver is produced by stuffing the geese with a food rich in proteids and carbo-hydrates, and preventing exercise. The fat is, therefore, manufactured in the body from that which is not fat.

Sugars and starches, then, are consumed in the body for yielding energy and heat, while any excess is converted into glycogen or fat and stored till required.

We may represent these conclusions in the following table:—

Uses of the Various Food-stuffs in the Body.

WATER	Required by all the tissues. Daily supply needed to replace what is given off from lungs, skin, and kidneys.	
SALINES or MINERAL MATTERS	Enter into the composition of all the tissues, and promote their healthy activity.	
PROTEIDS	1. Build up tissues, muscle, bone, nerve, &c., in the growing person. 2. Repair the tear and wear of the tissues, constantly occurring, irrespective of work.	**Excess** 1. May be directly consumed to yield energy and heat. 2. Part may be stored up as fat till required. 3. Part may be stored up as glycogen.
FATS	Undergo combustion to yield (1) Energy for work, (2) Heat.	**Excess,** Stored up as fat till required.
CARBO-HYDRATES (Sugars, Starches, &c.)	Undergo combustion to yield (1) Energy for work, (2) Heat.	**Excess** Stored up as (1) fat, (2) glycogen.

The practical conclusions from these considerations have been already indicated, but will bear repetition.

There is a marked difference, in the proportion of the various kinds of food-stuffs, between the diet suitable for the full-grown person and that for the growing child.

As regards the full-grown man—

1. He needs a quantity of proteids sufficient to repair tear and wear of tissues. This quantity is, broadly speaking, the same from day to day, and is not materially affected by the amount of work done.
2. He needs a quantity of fats and carbo-hydrates, increasing (1) with increased work, in order to yield an increased amount of energy, and (2) in a cold climate or in cold weather, to yield an additional quantity of heat, and decreasing with lessened work or warmer weather.

As regards the growing person—

1. He needs a quantity of proteids sufficient to repair tear and wear of tissues.
2. He needs, over and above, a quantity of proteids for purposes of growth.
3. He needs fats and carbo-hydrates according to exercise, external cold, &c.

These facts show at once the great value of milk as a diet for children, and its much less value as a diet for adults. It contains a quantity of proteids, relatively large in proportion to the fats (cream) and carbo-hydrate (sugar of milk) it contains, and thus meets the wants of growing tissues, but the adult needs a larger proportion of the fats and carbo-hydrates, for the doing of work, than it affords.

Setting water and saline materials aside as being derived from the inorganic world, the world of lifeless matter, it will help us greatly in realizing the extent of the proteids, fats, and carbo-hydrates, derived from the organic world, if we now give a list of the most commonly known food-stuffs, indicating into which of these classes they fall.

NITROGENOUS OR PROTEID FOOD-STUFFS.

From Animal Kingdom.	From Vegetable Kingdom.
Butchers' Meat of all kinds.	Beans, Peas, Lentils.
Poultry.	Wheat, Oats.
Wild-fowl.	Flour and Oatmeal.
Game.	Rye, Barley.
Fish.	Indian Corn, Rice.
Shell-fish.	Potatoes.
Eggs.	Vegetables of all kinds.
Milk.	Fruits of all kinds.

NON-NITROGENOUS OR CARBONACEOUS FOOD-STUFFS.

Sugars.	Starches.	Fats.
Cane-sugar.	Sago.	Butter.
Grape-sugar.	Corn-flour.	Dripping.
Beet-sugar.	Arrow-root.	Lard.
Treacle.	Tapioca.	Butterine or Oleo-Margarine.
Golden Syrup.	Cassava.	Oils, such as Olive and Almond Oil, &c.
Honey.	Tois-le-mois	
Manna.		

Gums also belong to the Non-Nitrogenous class.

With the knowledge we have thus far gained, it is possible for us to make some broad general statements. Thus we can say that a diet which consisted almost exclusively of corn-flour, arrow-root, or sago would be entirely an improper diet because of its want of nitrogen, and of its consequent utter inability to yield material for building up wasted tissues. But such general knowledge as this is of very limited value. We can say that beef is nitrogenous, and is, therefore, a food-stuff that will yield the material for repairing the waste of the body. But besides nitrogenous or proteid material, beef contains other substances, and we have as yet no information that will enable us to judge how much nitrogen one pound of beef may contain, and how much of it will be necessary for a day's ration. We have as yet no means of saying whether beef or beans supplies the nitrogen in largest amount. In order to obtain this fuller information a complete analysis of the various food-stuffs is necessary. Such complete analyses have been made. They show that any one of the nitrogenous food-stuffs named in the above table is really a mixture of two or three, sometimes of all, of the classes of food material tabulated on p. 538. Thus beef is a mixture of water, mineral matters, fat, and nitrogenous material; milk is a mixture of water, saline matters, fat, carbo-hydrate in the form of sugar, and nitrogenous matter in the form of curd; oatmeal contains water, mineral matters, carbo-hydrate in the form of starch, fat, and nitrogenous material—some, that is to say, of all the different classes of food-stuffs; and so on. This is shown in a very striking way in Plate IX., where the composition of various animal and vegetable food-stuffs is represented by variously coloured bands. Each band represents 100 parts of the food-stuff, say 100 lbs., and it is divided by small marks above it into 100 equal parts. The portion of the band marked blue represents the amount of nitrogenous material in the 100 of the food-stuff. The yellow part of the band

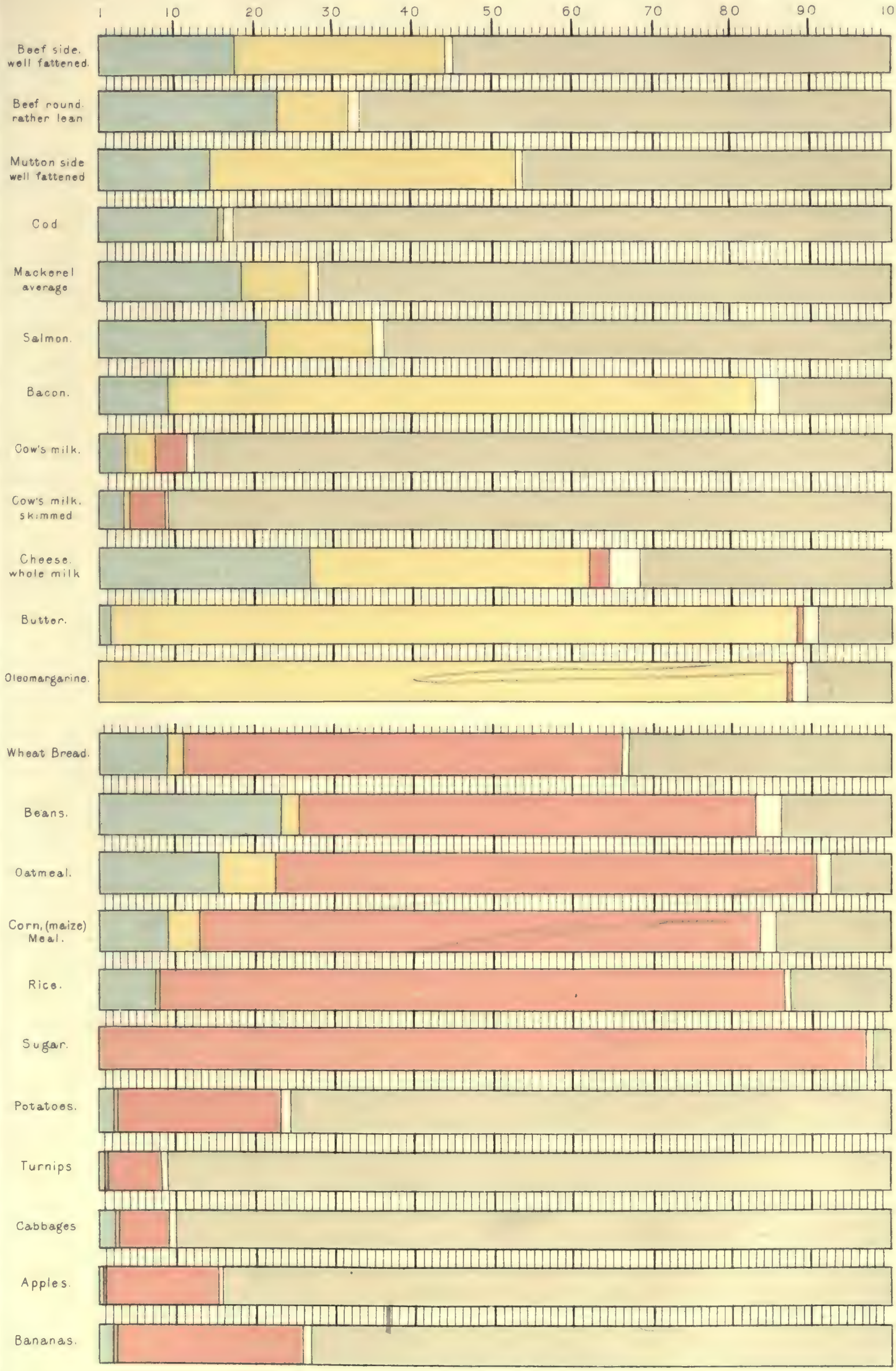
PLATE IX.—THE COMPOSITION OF FOODS.

Proteids or nitrogenous substances consist of carbon, hydrogen, oxygen, nitrogen, and sulphur. The type of proteids is white of egg. These proteid bodies are found in muscle, in nerve, in glands, in blood, and in nearly all the fluids of the body.

Carbo-hydrates are formed of carbon, hydrogen, and oxygen, the last two being in proportions to form water. Starch is a carbo-hydrate, and is found in the body in the form of animal starch. Sugar is another of this class of substances, and is found as **grape-sugar** in blood and liver, **muscle-sugar** in muscle, and **milk-sugar** in milk.

THE COMPOSITION OF FOODS.

Plate IX.



Each band represents the composition of 100 parts of the food-stuff. The fine lines between the bands are hundredths, and the fewer and darker lines are tenths. Each band is thus provided with a scale by means of which the proportion of each ingredient can be easily read off. The scale above the first band is numbered and by carrying the eye down the plate the number can be easily made to apply to the other bands also. Thus wheat-bread is seen to consist of proteids to the extent of 9 per cent. of fat to the extent of 2 per cent. of carbo-hydrates. (sugar and starch) to the extent of 55 per cent. of mineral matters 1 per cent. and of water 33 per cent. while butter contains about 1½ per cent. proteids, 87 per cent. fat, barely 1 per cent carbo-hydrates. 2 per cent. mineral matters, and rather over 8½ per cent. water.

Explanation of Signs.

Nitrogenous. or Proteids. — Fats. — Carbo-hydrates (Sugar & Starch) — Mineral Matters. — Water.

represents the fat, the red the carbo-hydrate (which may be sugar or starch, or a mixture of both), the white portion indicates the saline, and the black the amount of water. To give a complete example. Beef, from the side, well fattened, contains 17·5 per cent proteid, nearly 27 per cent fat, something over 1 per cent mineral material, and fully 54 per cent water, no carbo-hydrate.

With such analyses as these our knowledge of food-stuffs ceases to be vague and general, and questions as to the best food for building up tissues and for liberating energy can be readily answered, while we are supplied with the means of comparing various articles of food and determining their relative value.

We shall, therefore, now proceed to go over the various articles commonly used as food, giving tables of their composition. After that we shall be able to discuss fully questions relating to diets—what quantities and kinds of food ought to be used by the average person per day, and to give details as to how a diet should vary in accordance with varying circumstances of age, sex, work, and climate, &c.

COMPOSITION OF ANIMAL FOODS.

I. Nitrogenous Animal Foods.

BUTCHERS' MEAT.

Percentage Composition of Meat.[1] (Letheby.)

	Lean Beef.	Fat Beef.	Lean Mutton	Fat Mutton	Fat Pork.	Veal.
Water, ...	72	51	72	53	39	63
Nitrogenous, .	19·3	14·8	18·3	12·4	9·8	16·5
Fat, ...	3·6	29·8	4·9	31·1	48·9	15·8
Saline,..........	5·1	4·4	4·8	3·5	2·3	4·7

An examination of the above table reveals some very interesting facts. It will be noticed, first, that the proportion of water present in meat is very much higher than would ordinarily be supposed. It varies from about 50 to about 70 per cent. That is to say, 4 lbs. of lean beef, if perfectly dried, will shrink to rather less than 1¼ lbs. The second readily observed fact is that there is a relation between the quantity of water and the quantity of fat. It will be seen that when the proportion of water is large the proportion of fat is small, and when the proportion of fat becomes large the amount of water is diminished. Thus fat beef contains 21 per cent less water than lean beef, but 26 per cent more fat. Fat, that is to say, displaces water. This is quite in keeping with the popular notion that very lean beef is not economical. At the same time an excess of fat is undesirable and wasteful; for then it cannot readily be made use of, and, as the table shows, taking equal weights of lean beef and fat beef, there is less nitrogenous material in the fat than in the lean. The fat ought not to be in large masses on the meat, but should be distributed throughout it, showing as white lines running through the beef, giving it a marbled appearance. The amount of fat laid down in an animal's body is dependent upon a variety of circumstances. The kind of feeding has a marked influence, and the mode of life affects the fattening process in a very marked way. Animals in the wild state do not fatten. Fat is not laid down in the body, because carbonaceous substances are consumed in the body for yielding the energy needed in the state of unrestrained freedom. It is estimated that of the total weight of an ox ready for the market one-third is fat, and that fat forms rather more than the same amount of the body of a sheep.

There is also a considerable difference between the flesh of young and of mature animals. As a rule, while the flesh of the young animal is more tender, it is less nutritious and less digestible. Specially is it likely to be less nourishing if the animal has been quickly fed for the market. Enough time has not been given to permit the development of the muscular fibre, which is, in consequence, flabby and insipid. On the other hand if the animal has been too old or has been used for work, the flesh is too firm and hard to make pleasant eating.

Beef is said to be at its best when cut from the carcass of a four-year-old ox, and wether mutton from a three-year-old is in the best condition.

There is an important point on which the table is silent, and on which, indeed, chemical analysis can give no information, and that is flavour. It depends upon the presence in the meat of a series of bodies, which, because they can be dissolved out by water, are called **extractives** (see p. 537). They are found in greatest abundance in the flesh of wild animals, and it is their presence in more than usual quantity that gives to meat the quality people speak of as "richness." It is because the flesh of young animals is so deficient in these bodies that it is poorer and less tasty than that of the mature animal. Flavour also varies with the animal, the flesh of each kind having its own peculiar character. It is influenced by the feeding, being best just before removal from green pasturage

[1] These analyses differ considerably from those in Plate IX. The above are analyses of English samples, those of this Plate are American.

in the months of September and October; and it is diminished by artificial feeding. It is the natural feeding and the unrestrained life that give mountain-fed mutton the quality that makes it so desired. Turnip feeding imparts a particular kind of flavour.

The analyses given in the table apply to meat without the bone, and if any calculation is made, by means of the table, of the various nutritive materials present in, say 1 lb. of beef, as bought for domestic purposes in the ordinary way, due allowance must be made for the inevitable piece of bone. It has been calculated that of a whole ox carcass bone forms from 10 to 20 per cent of the whole weight, but the amount varies according to the cut.

Thus joints seldom contain less than 8 per cent of the weight in bone.
The neck and brisket contains 10 per cent do.
The shin and legs 33 to 50 per cent do.

Thus the most economical parts are the round and the thick flank, next in order comes the brisket, and lastly the leg. In mutton and pork the leg is the most economical and then the shoulders.

Bone, however, is not an innutritious portion of the animal, provided the nutriment is properly extracted from it. Church gives an analysis of the bone of a mutton chop, showing the following ingredients:—

Water	32·2	per cent or	5 oz. 66 gr. in 1 lb.
Nitrogenous	18·7	,,	2 ,, 434 ,, ,,
Fat	9·0	,,	1 ,, 193 ,, ,,
Saline {Phosphate and carbonate of lime}	40·1	,,	6 ,, 182 ,, ,,
	100·0		16 oz.

Smith, basing his calculation upon the analysis of shin-bones, estimated that

3 lbs. of shin-bones would yield as much carbon as 1 lb. of beef.
6 lbs. of shin-bones would yield as much nitrogen as 1 lb. do.

that is, the nutritive value of bone is as regards nitrogen $\frac{1}{6}$ that of beef, and as regards carbon $\frac{1}{3}$ that of beef. Bones vary in the amount of nutritive material they contain according to their form. Dense bone contains less animal and more mineral matter than spongy bone, and the more abundant the marrow the more useful the bone, for marrow consists largely of fat, and is therefore of value as yielding carbon for liberation of heat and energy. In order that the nutritive material may be properly extracted bones require grinding down. This could not be attempted for ordinary domestic purposes, but at any rate the bone ought to be well smashed up, to permit the extraction of as much nutriment as possible. The joint ends of bone yield, from the gristly material and from the tendinous and ligamentous parts about the joint, a substance which, on boiling, is converted into gelatine. It is this, perhaps, more than the nutritive material extracted from the bone itself, that makes the bone useful for the making of stock for soup.

Percentage Composition of Various Parts of Animals.

	Sheeps' Kidney.	Calves' Liver.	Tripe.	Foie Gras.	Bacon, fat salted and dried.
Water	78·60	72·33	67·1	22·70	13·9
Nitrogenous,	16·56	20·0	13·3	13·75	9·0
Fat	3·33	5.58	17·1	54·57	74·1
Carbo-hydrate.	0·21	0·45	—	6·40	—
Saline	1·30	1·54	2·5	2·58	3·0

The above tables show the nutritive value of the various internal organs noted. There are, however, objections to their use, mainly on account of their being difficult of digestion. Thus the kidney is of a close texture, and unless skilfully cooked, so that all the juices are retained, it may be hard and with little flavour. The same objection exists to the use of the heart, which closely resembles ordinary meat in its composition, though it is much firmer and harder. The liver is rich and savoury when properly cooked, but easily rendered hard and tasteless, and is difficult of digestion. Comparison between the table of calves' liver and foie gras, the fatty liver of Strasburg geese (see p. 541), indicates how the kind of feeding followed in the case of the geese alters the composition of the organ. The table shows the fatty liver to consist of over a half of fat. Tripe used as food consists of the paunch, or first portion of the stomach of the ox or cow. Of considerable nutritive value, it possesses the great additional advantage of being the most easily digested of animal foods, and it is of very agreeable flavour. Sweetbread is, strictly speaking, the pancreas (see p. 142), but the organ sold by butchers under this name is specially the thymus gland (p. 205), and other glands, such as the thyroid (p. 205), are also sold under the same name. The thymus of the calf is the most esteemed. It is nourishing, and when properly cooked easy of digestion. The lungs or lights are eaten along with the liver, and

though containing nutritious material are rather indigestible.

The blood of animals, chiefly the pig, is consumed in the form of black-puddings, which are made of a mixture of blood, groats, fat, and various herbs. The mixture is contained in a piece of skin from the intestine of the pig. Bacon belongs to the class of cured meats. The flitch is from the side. The process of curing consists in rubbing into the side a mixture of salt and saltpetre (nitre). Brine is also forced into the flesh by a force-pump. The sides, after being dressed in this way, are piled on one another for four days, then turned and sprinkled with salt, and allowed to lie for twelve days. After washing and drying they are hung in the smoke-house and submitted to the fumes of burning oak sawdust for three days, when they acquire the proper flavour and are ready for market. "For domestic use pork may be cured as follows: Stir some salt with hot water till no more of the substance is dissolved. This forms the brine or pickling liquor. Then mix, for a pig of moderate size, one pound of brown sugar and half a pound of nitre; rub this mixture well into the meat, which is then to be put into the pickle, remaining there two days. After this take it out and rub the pieces with salt alone. Return it to the pickle. It will be ready for use, after drying and smoking, in six or eight weeks" (Church). The small quantity of water contained in bacon makes it, weight for weight, of more nutritive value than fresh pork, while the pickling process renders the fat more digestible than it is in the fresh state. This is an exception to the general rule that curing renders meat less digestible. If the pickling has been too long continued, however, the lean portions will have become too dry by the abstraction of the juices. By noting in the above table the relative proportions of nitrogenous material and fat in liver and bacon, the meaning and advantage of combining these two in one dish becomes apparent, the one making up for the deficiencies of the other. The same is true of the combination of chicken and ham, for the flesh of fowls, as will be seen from the succeeding table, contains a very slight admixture of fat, while it is more than usually rich in nitrogenous material.

The same advantage is gained from a mixed diet of ham and eggs, veal and ham, bacon and beans, rabbit and ham, &c., the bacon or ham supplying in each case the fat, while the eggs, beans, veal, or rabbit yields in abundance the nitrogenous constituent.

POULTRY, GAME, AND WILD-FOWL.

Percentage Composition of Poultry and Game.

	Fowl.	Hare.
Water	73·15	74·35
Nitrogenous	22·65	23·34
Fat	3·11	1·13
Saline	1·09	1·18

The number of birds used as food, in various parts of the world, is very great. The analysis of the common barn-yard fowl may be taken as a fair sample. It will be noticed that the proportion of fat is small, and the proportion of nitrogenous material large, the latter existing in larger quantity even than in lean beef. Wild-fowl contain still less fat. The flesh of the white-fleshed birds is more tender, more delicate in flavour, and more easily digested than the dark-coloured flesh, for example, of ducks and geese. The latter is, however, richer and more stimulating. Game-birds are desired for their special flavour, which, by stimulating the appetite, counterbalances the disadvantage of the increased firmness and solidity of the flesh. The character of the flesh is, of course, influenced by domestication. If prevented from obtaining exercise, the birds will become fat, and it also appears that, after spaying, the animal fattens more easily, grows to a larger size, and develops a finer flavour. A *capon* is a cock-chicken which has been thus treated, a *poulard* is a spayed hen. The flavour is also markedly different in flesh-eating from that of grain-eating birds. The flesh-eating bird is of a stronger, fuller, and less agreeable flavour, and the feeding of such birds on grain greatly improves them in this respect. The keeping of game, till it is decidedly "high," is for the purpose of making the flesh more tender and easily eaten.

The breast is not always the most tender part of the bird. It is so in the common fowl and the partridge, because these birds walk rather than fly, and the wings and breast muscles are less exercised. But, in the case of the woodcock and snipe, the legs are preferred, because these birds fly most, and the wings consequently are firmer from exercise.

While there seems to be no bird whose flesh is injurious, if eaten, it yet appears that some birds may become poisonous by eating certain foods. The pheasant of North America is said to be poisonous during the winter and spring, if fed on the buds of *Calmia latifolia*, and American partridges have been found to possess poisonous properties (Pavy).

The flesh of hare and rabbit resembles that of fowl rather than that of butchers' meat. It also is characterized by the absence of fat. The flesh of the hare is particularly rich and nourishing, that of rabbit having a less defined flavour; but it is more easily digested, and, just because of its greater delicacy, is more suited for an invalid or convalescent. Hare-flesh is highly nutritious, but is rather for the healthy and vigorous than for the sick.

Venison, the flesh of the deer, resembles game rather than butchers' meat. It possesses little fat, but is rich in extractives, and therefore savoury and stimulating. It is, moreover, readily digestible. The flesh of park-deer resembles that of the domestic sheep because of restricted exercise.

Squirrels are eaten in some of the western parts of America, and by the natives of Australia, and form a favourite dish in Norway and Sweden. The flesh is said to be tender, and to resemble that of the barn-door fowl. The flesh of the opossum is compared to that of the rabbit or hare.

Edible birds' nests are esteemed great delicacies in China. The edible portion of the nest is really formed of dried saliva, and is constructed by the bird, the salangan, a kind of swift, as a support on which its nest is afterwards raised of grass, leaves, and sea-weed. The birds build in caves near the sea or inland, and it is by means of the brackets which the animal makes, that its nest is supported. It is said to require fifty such brackets to make up a pound in weight, and the best of them sell for £5 to £6 the pound. They are obtained chiefly in the islands of the Southern Archipelago.

EGGS.

Percentage Composition of Hen's Egg (*Church*).

	White.	Yolk.	White and Yolk Mixed.
Water	84·8	51·5	71·7
Nitrogenous	12·0	15·0	14·0
Fat	—	30·0	11·0
Extractives and membranes	2·0	2·1	2·0
Saline	1·2	1·4	1·3

The eggs of a great variety of birds are used as food, and there is no bird's egg which may not be so employed. The eggs of different birds differ much not only in size, &c., but also in flavour. The flavour is mainly determined by the feeding of the bird.

Within the shell the whole egg is inclosed in a delicate double envelope or membrane. Throughout the white of the egg run delicate strands of membrane dividing off compartments in which the semi-liquid white is inclosed. Within the white, inclosed also in a delicate membrane, is the yellow yolk attached to the membranes of the white by two fine cords or chalazæ, one towards each end of the egg, which suspend the yolk and permit it to move readily within the white. It is on the yolk and from a part of it that the young bird is developed. The part is indicated in the fresh egg by a small white area, called the cicatricula, about the sixth of an inch in diameter, which is always uppermost in whatever position the egg is placed. The rotation of the yolk on its chalazæ achieves this. While only a part of the yolk developes into the young bird, the remainder and the whole of the white serves to nourish it till it is ready to break out of the shell. So that within the egg itself is contained all the material necessary for the development of the tissues and growth of the chicken during a considerable period of its existence.

The shell is usually about the $\frac{1}{10}$th of the total weight of the egg, the yolk weighs $\frac{3}{10}$ths, and the white $\frac{6}{10}$ths.

The shell consists of 3 per cent organic matter, and 97 per cent inorganic salts, of which 91 per cent is carbonate of lime, and the remaining 6 per cent is phosphate of lime. It is porous, and thus permits exchanges to go on between the air outside and the contents of the shell. It is because of the entrance, through the shell, of putrefactive germs in the air that decomposition is set up, and the egg becomes bad. This may be prevented by rubbing newly-laid eggs over with fat or butter, which enters the pores and seals the egg, as it were, against the entrance of air. Eggs have been kept fresh for two years, and may easily be kept, it is said, by covering them with a solution of one-third bees'-wax and two-thirds olive-oil. They may be kept for a considerable time also by packing them, small end downwards, in clean dry salt. They may be preserved also in strong solution of salt or in lime-water. Bad eggs swim even in pure water because of their loss of weight owing to decomposition, and the quantity of gas the decay has produced. Good eggs should sink in a solution composed of 1 ounce of salt in 10 ounces ($\frac{1}{2}$ pint) water, and in the same solution indifferent eggs float. The white and yolk of eggs differ very much in their composition, as the tables show. The white is almost entirely a weak solution of albumin in water, for the nitrogenous constituent is pure albumin (see

p. 536), and the water exists to the extent of nearly 85 per cent. So that of the white of egg only ⅛th part consists of really nourishing material, namely, the albumin. Though in solution in cold water, it becomes coagulated into a white clot when heat is applied, and the albumin in this coagulated condition will no longer dissolve in water. When the composition of the yolk is examined, a marked difference is observed. There is 33 per cent less water, and 30 per cent fat, besides 3 per cent more albuminous or nitrogenous material. The fat may be extracted as a bright yellow oil by means of alcohol or ether. The yolk is much richer then, and more nourishing than the white. Yet the white forms $\frac{6}{10}$ths of the whole egg, so that when the mixed white and yolk are taken, the rich yolk is diluted, as it were, by the weak white, as will be seen on referring to the table. It is sufficiently plain from these tables that eggs are not the concentrated food most people imagine. As a matter of fact an egg scarcely contains more nourishing material than a piece of beef of equal weight. This is proved in more detail on p. 555. A man, restricting himself to eggs alone, could not obtain sufficient waste-repairing and energy-yielding material out of less than eighteen eggs per day.

The inorganic salts of the egg are those of phosphorus, iron, lime, soda, potash, and magnesia.

The weight of the hen's egg is from 1½ to 2 ounces; a duck's egg weighs 2 to 3 ounces, a turkey's 3 to 4 ounces, and that of a goose 4 to 6 ounces. A duck's egg contains a fourth more nourishing material than a hen's egg.

FISH AND SHELL-FISH.

Percentage Composition of White Fish.

	Whiting.	Cod.	Haddock.	Sole.	Skate.
Water........	83·0	77·5	78·0	86·1	73·79
Nitrogenous	15·1	18·5	18·1	12·0	24·03
Fat............	0·8	3·0	2·9	0·7	0·47
Saline.........	1·1	1·0	1·0	1·2	1·71

Percentage Composition of Fat Fish.

	Herring.	Mackerel.	Eel.	Salmon.
Water............	80·71	68·27	79·91	74·45
Nitrogenous....	10·11	23·42	13·57	18·75
Fat..................	7·11	6·76	5·41	6·22
Saline	2·07	1·55	1·11	0·58

In the above tables a rough distinction has been made between two classes of fish, depending on their chemical composition. To the class of lean fish, that is, with comparatively little fat in their composition, belong the fish with more or less white flesh. The commoner examples of this class are given in the table, and to the same class, with a chemical composition of which that of the haddock may be taken as an average, belong turbot, brill, plaice, whitebait, smelt, flounder, hake, ling, gudgeon, and pike. The class to which herring, salmon, &c., belong is characterized by a considerable increase in the quantity of fat, and has usually flesh more or less coloured. The sprat, pilchard, and lamprey belong to the same class. According to the table the herring is richest in fat; but the eel is usually represented as one of the fattest of fish, Letheby's analysis crediting it with nearly 14 per cent of fat, and Payen stating the percentage of fat in the eel, when the non-edible parts have been removed, as nearly 24. It may be remarked here that there are considerable variations in the analyses of different food-stuffs, as given by different authorities, depending upon the state of the particular samples from which the analyses were made. Thus in fish the composition varies with the season, the animal being at its highest state of perfection previous to spawning, when it is fatter, and the flesh has a richer flavour. After spawning the animal is much leaner and the flesh is more watery. It is estimated that during the spawning period as much as 17 per cent of the total fat present in the body may disappear.

In the case of the salmon, herring, mackerel, eel, &c., the fat exists among the muscular substance, and there is also a layer of fat beneath the skin, specially beneath the skin of the belly, whereas, in the cod, skate, &c., the fat is present in greatest amount in the liver, which is, in the season, gorged with oil.

Fish compares favourably with butchers' meat, containing a nearly equal amount of nourishing material, weight for weight, as beef. The extractives, to which butchers' meat owes its richness and fulness of flavour as well as its stimulating properties, are present in less quantity, however. Fish is thus less satisfying and stimulating than beef, and is, on that account, not so extensively used as it ought to be. Because of this, however, its nutritive value is not actually impaired, while these qualities make it of much value to persons of weak digestion and to persons of sedentary habits. Its deficiency, specially the deficiency of white-fish, in fat is easily made up by mixing the diet with fatty substances. Butter sauces, for example, make up for this. Fishing populations

have learned this by experience. Thus the people of Cornwall and Devonshire make a fish-pie of fish mixed with thick pieces of fat pork, salted and peppered,and covered by a good crust. They thus obtain all the requisites of a nourishing meal; and the healthy condition of the people shows how satisfactory is the diet. "In no other class than in that of fishers do we see larger families, handsomer women, or more robust and active men" (Dr. Davy). The value of fish from an economic point of view, as compared with butchers' meat, is discussed on p. 555.

The flavour of fish varies with their feeding, the special character of the feeding-ground being the cause of the peculiar excellence of Loch Fyne herring, Dublin Bay haddock, Dogger Bank cod, and Tay salmon. The whiting is the most delicate and tender, and near it is the haddock; the sole, flounder, turbot, cod, hake, and ling follow. The white-fish are the most digestible; and diminished digestibility accompanies increased firmness of flesh. This is seen in cod-fish, which in season is firm, and becomes opaque on boiling, showing curdy material between the flakes. But this very firmness, desirable as indicating seasonableness, is a disadvantage from the point of view of digestion. The firmness of the cod is increased by crimping, which consists in making cross-cuts into the flesh immediately after the fish is killed, and then plunging it into cold water. This is supposed to improve the flavour. The flavour of some fish, such as trout and salmon, is best when they are cooked and eaten speedily after being killed; but others, such as turbot, improve with keeping. The fat fishes are the least digestible of all.

Roe and milt are parts of the reproductive organs, the former, which is the hard roe, belonging to the female, and the latter, the soft roe, to the male. Caviare is the preserved hard roe of the sturgeon.

Many substances of great commercial value are made from various parts of fish. Thus isinglass is derived from the swimming-bladder, specially of the sturgeon. Glue is made from refuse of fish; and so on. The Normal Company, of Aberdeen, has shown that every part of the fish can be utilized, and that the parts of the fish regularly discarded as useless, when properly made use of, represent an enormous money value.

Fish sometimes possess poisonous properties, possibly because of some kind of feeding. Such poisonous fish are met with in the tropics. There are some people injuriously affected by fish at any time, even as others cannot eat mutton or eggs without great disturbance.

There does not seem any scientific ground for the popular notion that fish is a specially useful food for brain workers. It was thought that fish were rich in phosphorus, which enters into the composition of brain tissue, and were, therefore, specially useful. This idea arose from the glow given out by fish in the dark. But such phosphorescence is probably due to a minute organism, and is a thing apart from the chemical composition of the fish.

Percentage Composition of Shell-Fish.

	Lobster.	Oysters.	Mussels.
Water,	76·62	80·38	75·74
Nitrogenous,	19·17	14·01	11·72
Non-nitrogenous and loss,	1·22	1·40	7·39
Fat,	1·17	1·52	2·42
Saline,	1·82	2·69	2·73

The above may be taken as fairly representative of the shell-fish class. They contain a fair quantity of nourishing material. In the case of lobster, crab, crayfish, &c., there are serious objections to their use. They are among the most indigestible kinds of animal food. They are coarse feeders, and this may account for the disturbing effects they so readily produce, apart altogether from any difficulty of digestion. Under any circumstances, however, they excite even serious irritation of stomach and bowels in some persons, producing cramp, colic, purging, and violent symptoms of irritant poisoning; while in others the partaking of even a small amount of shell-fish (and specially mussels) to supper would induce a skin eruption like nettle-rash. Oysters are not so open to this objection; indeed they are frequently found pleasant and appetizing by persons of weak digestion and convalescents. The flesh of the claws of lobsters and crabs is more delicate and digestible than the soft internal parts, which are mainly liver. The mass of little round black bodies, found beneath the tail of the female lobster, is the spawn, and is used for sauce. The beard of the oyster is formed of the gills, and is frequently removed; the large hard portion of the interior, which is a muscular part, ought also to be rejected, as it is the least digestible part. The addition of vinegar, spices, &c., to shell-fish is, as a rule, an aid to their digestion, as these substances act as stimulants to the stomach and promote the flow of the digestive juices. Oysters are more easily digested when raw than when cooked. They are in season only when there is an "r" in the name of the month.

TURTLE.

Both the fresh-water and marine turtle are consumed as food. The former abounds in certain districts of the Continent, and is used by the inhabitants. The *terrapin*, a fresh-water turtle, is imported into this country from America. Land tortoises are also found wholesome and agreeable food by the natives in India and Africa and by the North American Indians.

The edible or green turtle (*Chelonia mydas*) is the one chiefly used in this country. It is from 6 to 7 feet long, and sometimes weighs 700 pounds. They are imported alive; and the flesh cut up into pieces and sun-dried is also imported in large quantity from the West Indian islands. The flesh is sometimes used as steak, but is principally employed for soup. For this purpose the shields covering back and belly are removed from the animal, scalded to allow of the removal of the scales, and boiled. The soft, glutinous parts are then removed from the hard bony portion and cut up into small oblong pieces. It is these pieces that are prized, and are erroneously called green fat. The liquor is used as stock for soup. The shield from the back is called callipash (the carapace of naturalists) and that from the belly callipee—names well known to cooks, epicures, and aldermen. "The callipee, or underpart of the breast or belly, baked, is reckoned the best piece." It is white, like veal or chicken, after being boiled. The meat from the callipash is dark-coloured, and is sometimes called black or green meat. The fat of the turtle is greenish-yellow in colour, and it also is used for soup. It is said to colour the urine and sweat of those who eat of it. Turtle is said to be highly nutritious, and when plainly cooked easy of digestion—tender, delicate food when young, but more tough and gristly as it grows old. "The juices are generally reckoned great restoratives."

The eggs of the turtle are also used as food. They are deposited in great numbers in the sand of the bays and lagoons, to which the turtle resorts for that purpose several times a-year. They are hatched lying in the warm sand, and the difficulty is to procure them in a perfectly fresh state.

The flesh of the turtle is about 75 per cent water, and of the remaining 25 per cent about one-half is fat, the rest being flesh.

Mock-turtle soup is made with pieces of the gelatinous portions of the scalp of the calf's head, which resemble to some extent the glutinous pieces of turtle.

MILK.

Average Percentage Composition of Human Milk and Milk of Different Animals.

	Human	Cow.	Ass.	Goat.	Mare.	Sheep.
Water,.........	88·0	86·87	91·17	87·54	88·80	82·27
Nitrogenous,.	2·97	4·65	1·79	3·62	2·61	7·10
Fat (Butter),.	2·90	3·50	1·02	4·20	2·50	5·30
Sugar,..........	5·97	4·28	5·60	4·08	5·59	4·33
Saline,..........	0·16	0·70	0·42	0·56	0·50	1·00

Milk is an emulsion. It consists, when seen under the microscope, of a multitude of exceedingly fine globules of oil, each globule being surrounded by an albuminous film, which keeps the globules from running together, the globules floating in an opaque fluid. The fluid contains albuminous bodies, milk-sugar, and salts, in solution. When perfectly fresh it is slightly alkaline in reaction, but it soon becomes somewhat acid.

When milk is allowed to stand the oil-globules, being light, rise to the surface and form the layer of cream, so that the cream is mainly the fatty portion of the milk, the globules in it being still separated from one another by the albuminous envelopes. When milk is churned, the albuminous envelopes are ruptured, and the released globules of oil run together, forming little masses of fat. These masses are collected, as much of the liquid squeezed out as possible, and thus the butter is obtained. If a small quantity of acid, say common vinegar, be added to milk and the milk be slightly warmed, it separates into curd and whey. The same thing occurs if the milk is allowed to stand till it becomes sour. The souring is due to the formation in the milk of an acid—lactic acid. The lactic acid is produced by a species of fermentation from the sugar present in solution in the milk. The agent in exciting this fermentation is a minute organism (see p. 389) deposited in the milk from the air. If milk be heated, and corked in a bottle when hot, it will not turn sour, because the heating has destroyed the organism; and no lactic acid being produced, curdling will not occur. But if the cork be removed and the air have access to the milk again, fresh organisms are deposited and curdling will soon take place. The explanation of curdling is this: the chief nitrogenous or albuminous body in milk is called casein. Casein belongs to the same type of substances as white of egg. We all know that white of egg will dissolve in cold water, but as soon as the water is heated to the boiling point it separates or is precipitated as a white curdy mass. Now while

casein of milk is akin to white of egg, unlike it, it does not precipitate on boiling, so long as the solution, in which it is present, is not acid but alkaline. As soon as the solution becomes acid, either by the addition of a little vinegar, or by the process of souring, the casein tends to become precipitated as curd, and will be all the more quickly precipitated if the solution is heated. So long as milk is kept alkaline, then, it will not curdle, because casein is soluble in an alkaline solution, and is therefore called alkali albuminate. The addition, therefore, to milk of a little common baking-soda (carbonate of soda) will prevent curdling taking place. Milk is also separated into curd and whey by mixing it with rennet. Rennet is prepared from the stomach of the calf, and contains a special ferment, which causes the precipitation of the casein. In the process of the digestion of milk in the stomach curdling is the first step, being caused by the acidity of the gastric juice, as well as by the presence in the juice of a curdling ferment. If a person vomits some time after a drink of milk, the milk is returned in a curdled condition, because the process of digestion has begun.

The curd of milk thus consists of an albuminous body casein, and entangled in the curd is the most of the milk-fat. The whey also contains some of the fat globules, and is, therefore, somewhat opaque. It contains also a small quantity of albumin of exactly the same character as white of egg, and it contains in solution the sugar, salts, &c., which can be readily separated out. If the whey be gradually evaporated the milk-sugar will crystallize out.

Milk, then, is really a very complex substance, and it contains a proportion of all the different kinds of material needed as food—nitrogenous, fatty, sugary, saline.

We must now look at its composition a little more in detail. It will be observed from the table that the composition of milk varies very much in different animals, that of the ass containing a total of only 8·83 parts of solid material in 100, while that of the sheep contains double the amount of nourishing material, namely 17·73 parts in the 100; and while

human milk contains 12 parts of solids in 100,
cow's milk „ 13·13 „ „

Solids in One Pint of Milk.

Nitrogenous, ...	369 grains.
Butter, ...	351 „
Sugar, ...	468 „
Saline, ...	72 „
Total Solids, ...	1260 grains.
Or fully	2·8 ounces.
Water, ...	17·9 „

Of one pint of cow's milk (20 ounces) 17½ ounces in round numbers are water, and 2½ ounces solid nutriment. If a grown person, therefore, were to live on milk entirely, a very large quantity would be necessary—between 9 and 10 pints daily at least. This would be an expensive diet. It is one, moreover, not suited as an exclusive diet for an adult, while eminently suited for a young growing person (see p. 542).

The nitrogenous ingredients in milk are principally the two already named—egg-albumin and alkali albuminate or casein, the casein being in largest proportion, forming nearly 4 of the 4·65 per cent.

Milk-fat or butter or cream is that which gives the quality and richness to the milk. It is by the amount of cream present that the quality of the milk is commonly estimated. There is a simple instrument, called a creamometer, which might readily be employed in households for determining the richness of milk. It consists of a test-tube (fig. 192) 11 inches long and ½ inch in diameter, which is divided into 100 degrees by a scale. The milk to be tested is well shaken to mix the cream uniformly and then the test-tube is filled with it up to the mark 0. The tube is allowed to stand upright for 24 hours, and the depth of the layer of cream on the top read off at the end of that time. Good sweet milk should give a layer of cream not less than 11½ degrees. This is, however, not a very reliable gauge, because the amount of cream which rises depends on many conditions. More cream will rise if the temperature is low, if the vessel which contains the milk is wide, and if the vessel is kept perfectly free from agitation. Another method of determining the quality of milk, which gives results varying according to whether the cream has been removed or not, is the method by taking the specific gravity of the milk. A hydrometer is used, such as is shown in fig. 193, which should sink in pure water to the level of the mark 0, which stands for 1000. In pure sweet milk it should rise to a level between 29 and 33 (1029 and 1033). That is to say, the specific

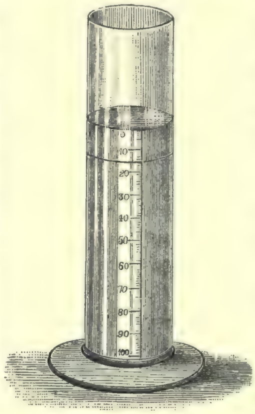


Fig. 192.—Creamometer.

gravity of pure milk varies between 1029 and 1033. Now such milk contains say about 12 per cent of cream, and if from a sample of pure milk any quantity of cream has been skimmed, the reading from the hydrometer will be considerably different. Cream, consisting as it does mainly of fat, is lighter than water. If, therefore, a large quantity of cream be present in a sample of milk, its specific gravity will be lowered; and if the cream be skimmed off, the specific gravity of the milk will be raised. Thus pure milk with all its cream, which gives a specific gravity of between 1029 and 1033, will, if the cream be removed, give a specific gravity of between 1033 and 1037. If we take these two levels as the standards of pure sweet milk and pure skimmed milk, it is plain that the addition of water to either will cause a lowering of the specific gravity. A table has been constructed, showing the fall for varying quantities of water, and thus, by using the hydrometer, with this table a rough estimate of adulteration of the milk with water might be made.

Fig. 193. Hydrometer.

Table Showing Specific Gravity of Milk before and after Removal of Cream with Different Quantities of Added Water.

Specific Gravity before Removal of Cream.	Specific Gravity after Removal of Cream.	
1029 to 1033	1034 to 1037	Indicates Pure Milk.
1026 ,, 1029	1029 ,, 1034	= 10 p.c. added water.
1023 ,, 1026	1026 ,, 1029	,, 20 ,, ,,
1020 ,, 1023	1023 ,, 1026	,, 30 ,, ,,
1017 ,, 1020	1020 ,, 1023	,, 40 ,, ,,
1014 ,, 1017	1016 ,, 1020	,, 50 ,, ,,

Hydrometers are graduated for use with milk only, and are then termed **lactometers.** Different makers graduate the lactometers in different ways. Thus one is made graduated from 100, low down on the stem, to 0 at the top of the stem. In pure water it would sink to 0, in pure milk the stem would stand out above the milk to the level 100. If it sank so that the stem stood out to the level 90 only, that would indicate that, in 100 parts, only 90 were pure milk and 10 were added water, and so on. The graduation might begin low down at 0, at which level the lactometer should stand in pure milk, and from that point up the stem the marks would indicate percentages of added water. Thus if the instrument sank to 5, that would mean 5 per cent added water. If this method of testing the quality of milk were used, and it would be of easy domestic application, it should be employed in conjunction with the creamometer, else mistakes would arise. Take an example: a fraudulent milkman might remove a portion of cream from his milk, and in consequence the specific gravity would rise, say to 1034, indicating skimmed milk. He might then bring the specific gravity back to what it ought to be for pure milk by adding water. Of course the milk would look thin, but still the specific-gravity test alone would not indicate anything wrong. If, however, the creamometer test were applied, and a marked deficiency in cream shown, the explanation would be evident. For purposes of such testing the milk should be well mixed before the sample is poured out.

The sugar of milk or lactose contains the same proportions of carbon, hydrogen and oxygen as cane-sugar, but is of feebler sweetening power, and does not readily undergo the alcoholic fermentation, but is prone to the lactic acid fermentation, which, as already stated, is the cause of the souring of milk.

The **saline constituents** consist of salts of soda, potash, lime, magnesia; oxide of iron, and compounds of phosphorus and chlorine are also present. Milk also contains fluorine, which is an ingredient in teeth. Of the total mineral constituents phosphoric acid forms no less than about 28·5 per cent.

The composition of milk varies much with the feeding of the animal. If an abundance of suitable food be allowed to the cow, and exercise be denied, the yield is increased, and the quantity of solids in the milk is also increased. Stall-fed cattle yield more butter, because less fat is consumed in the body for yielding energy for exercise and the maintenance of temperature.

The flavour of the milk is also influenced by the feeding, the finest being yielded by feeding on fresh country pasture. Turnips and fragrant grasses impart an odour to the milk. Milk also may be coloured by food eaten, and may acquire poisonous properties, without the animal being affected, by the cow, goat, &c., feeding on certain plants. This is noticed in Malta and some districts of North America.

The milk of a cow varies also at different times of the day, and the milk obtained at one milking is not all of the same richness. The afternoon milk is said to be twice as rich in butter as the morning milk. If, as a cow is being milked, the milk is divided into several portions as it comes from the udder, the milk that came first is found to vary very much from

that yielded by the stripping of the udder. The chief difference is in the quantity of butter, the first milk, or as it is called the "fore" milk, being very poor in fat, while the last milk, or the "strippings," is rich in fat. Any one, therefore, who wishes to see a fair sample of milk yielded by a particular cow should see the cow completely milked. The whole milk should be collected in one vessel, and a sample of that taken. The cause of the difference is found in the lightness of the cream, which makes it rise to the highest part of the gland.

The average quantity of milk yielded by the cow varies with the breed. The Yorkshire shorthorn, the favourite of London dairymen, is estimated to yield on a yearly average nearly a gallon and three quarters per day (strictly 1·7 gallons per day). A good average yield is said to be 15 pints per day, but, as already stated, it varies with the feeding, exercise, &c., not to speak of the condition of the animal. The udder of the cow is estimated to be able to contain about 5 pints of milk at one time.

As an agent in the communication of disease milk must not be ignored. It is perfectly certain that milk is continually the agent in spreading typhoid fever. Probably, indeed with certainty, this arises from water tainted with excretions from a patient suffering from typhoid fever, gaining access to the milk. A very common story is that some farm hand takes ill with what is called a feverish cold or gastric fever, and is ill for some weeks. The discharges are, without any precaution, cast on the dung-heap, and fluid from it finds its way into the burn or well, from which the household obtains water. This water is used to wash the milk-vessels, not to say to add to the milk, and is then conveyed to a neighbouring town or village. Germs from the patient have thus gained entrance to the milk, where they multiply, and if the milk be used unboiled, it may convey the disease to whomsoever partakes of it. In recent years it has also become almost certain that the milk of a diseased cow may occasion disease in persons partaking of it. An outbreak of scarlet fever in Hendon, in England, and another in Glasgow, were almost conclusively traced to the use of milk, yielded by cows suffering from a febrile disease, and it has become highly probable that the scarlet fever of the human subject has its counterpart in the cow, and that it may pass from the cow to the human being by the medium of the milk. Another disease that numerous investigations have shown to be probably communicable from the cow to man by the medium of milk is tubercle, the chief if not only cause of consumption of the lungs (see p. 277). It is becoming more and more certain that specifically tainted milk is constantly sold in large towns, and the question for each one to ask is, how protection against it is to be secured. It has been shown that milk containing infection may evidence to chemical analysis no change whatever, and there is really no test of quality, taste, flavour, &c., which is of any value on this question. If the milk consumer wishes any guarantee of protection, the only one of real use he can himself supply *by bringing to the boiling point, and keeping boiling for one or two minutes, every drop of milk that enters his house*, the vessel into which it is poured from the pot being previously scalded. That is to say, to be thorough, the milk is not to be poured from the pot back into the vessel, which held it at first, unless every particle of unboiled milk has been removed from the vessel by boiling water. **Human milk** varies with feeding, &c., much as cow's milk does, and is altered by disease. Medicines administered to a nursing mother may affect the child, and, therefore, caution in giving such drugs, as mercury, opium, laudanum, &c., to a nurse is necessary. Human milk, as shown by the table, contains less nitrogenous and fatty material than cow's milk and more water and sugar. To bring cow's milk more nearly to the composition of human milk, the addition of water and sugar is necessary. The following quantities are advised:—

20 ounces (1 imperial pint) cow's milk,
10 ounces (½ ,, ,,) boiling water,
1½ ounces sugar (preferably milk-sugar),
Mix.

It is said that cow's milk coagulates in larger curds than human milk, and that this accounts for the greater difficulty infants experience in digesting cow's milk. This is remedied by boiling, which causes curdling to occur in more flaky masses.

Percentage Composition of Cream, Skim-milk, Butter-milk.

	Cream.	Skim-milk	Butter-milk.	Devonshire Clotted Cream.
Water, ...	55	89	90·62	28·68
Nitrogenous, ...	6	4·3	3·78	4·05
Butter, ...	36·3	0·4	1·25	65·01
Sugar, ...	2·5	5·5	3·70	1·77
Saline, ...	0.2	0·8	0·65	0·49

Cream.—The composition of cream varies very considerably, the quantity of fat varying as much as between 12 and 50 per cent, and

the water in like proportion. Much depends upon the method employed for the removal of the cream, centrifugal machines performing the process more completely than the old method.

Skim-milk varies in composition for the same reason, but the percentage of sugar is always higher than in uncreamed milk.

Devonshire Cream is of a pasty consistence. It is obtained by keeping the milk in large pans at a moderate heat for a prolonged period, and removing the scum that rises to the surface.

Butter-milk, though it is what is left of the milk after removal of the butter by churning, yet contains a quantity of butter in minute particles. Owing to the souring which has taken place, however, much of the sugar is converted into lactic acid, though it is stated in the table as sugar, and the longer it stands the more complete does this conversion become. It is rich in nitrogen, and with other food is a valuable article of diet.

Percentage Composition of Condensed Milk.

	Anglo-Swiss Coy.'s, made in Switzerland.	Made in England.	American (no Cane-sugar added).
Water,	24·13	24·99	48·59
Nitrogenous,	13·67	10·02	17·81
Butter,	8·67	10·88	15·67
Milk-sugar,	10·82	11·92	15·40
Saline,	2·23	1·96	2·53
Added Cane-sugar	40·48	40·23	——

Condensed Milk.—The above analyses give a fair idea of the average composition of condensed milk. The usual method of preparation is to evaporate the milk in vacuum-pan and then to heat to the boiling point, cane-sugar being added. The milk is then preserved in tightly-soldered tins, so that air has no access. In other cases the milk is concentrated, no cane-sugar being added, so that the simple milk deprived of most of its water is obtained. Of the former kind two analyses are given, showing fully 40 per cent added cane-sugar. This makes such milk exceedingly sweet and unpleasant to many people, though the presence of the sugar enables the milk to keep for a considerable time after the tin has been opened. Of the unsweetened kind one analysis is given. It keeps for a much shorter time after the tin has been opened. On the other hand, it will be observed that this latter kind contains, weight for weight, much more actual milk solids than the former. Thus the unsweetened contains, in 100 parts, 51·41 parts of the actual solids of milk, curd, butter, milk-sugar, and salts, while the sweetened variety contains, in 100 parts, only 35·39 of actual milk solids, though the total solids in 100 parts are brought up to 75·87 by the added cane-sugar. To put it in another way, by the lowest estimate good milk contains not less than 9 parts in 100 of solids, not counting butter. If, therefore, the total solids, excluding butter, present in a sample of condensed milk, be divided by 9, the figure obtained will indicate the amount of condensation to which the milk has been subjected, and, therefore, the original quantity of milk represented by the condensed sample. Thus, in the third analysis given above the total solids, excluding butter, are—

Nitrogenous, ...	17·81
Milk-sugar, ...	15·40
Saline, ...	2·53
	35·74

which, divided by 9, gives 3·97,

as nearly as possible 4. That is to say, the milk has been concentrated 4 times, or the 100 parts condensed milk represent 400 parts of the original milk. If one table-spoonful of this condensed milk be made up to four table-spoonfuls with water, one has restored the degree of strength of the original.

Now take the first sample, it contains of solids, not including butter,

Nitrogenous, ...	13·67
Milk-sugar, ...	10·82
Saline, ...	2·23
	26·72

which, divided by 9, gives 2·97, say 3.

This milk has been concentrated only 3 times; 100 parts represent only 300 of the original, and one table-spoonful would stand bringing up to only 3 with water to restore the original strength. Of course it has, in addition, cane-sugar, but when one buys condensed milk it is not cane-sugar one pays for, and when one feeds an infant on condensed milk it is not syrup one wishes to give.

The use of the simple rule given above will enable consumers of condensed milk to measure exactly what they are doing. When they buy the tin of milk, if its composition is not stated on the tin, let them ask for a note of its composition. The dealer who supplies it will also be able to obtain this for them. With the table of composition before them, let them sum up the total of the percentages of "solids not fat," that is, the totals of the nitrogenous or albuminoids, the milk-sugar (not the cane-sugar), and the saline, and divide the total by 9. They will thus know how much to bring the condensed up to with water to get the composition of pure

milk, and if it is for an infant it can then be further diluted according to the age of the child.

Percentage Composition of Koumiss.

Water, ...	87·87
Nitrogenous, ...	2·83
Milk-sugar, ...	3·76
Lactic Acid, ...	1·06
Butter, ...	·94
Alcohol, ...	1·59
Carbonic Acid, ...	·88
Saline, ...	1·07

Koumiss is obtained from milk by fermentation. It is specially a drink of the Tartars, and is prepared by them from the milk of the mare. Camel's milk is used for its production by the Arabs. Other kinds of milk may also be employed. Cows' milk sweetened is used in London. The actual composition of the koumiss in each case will depend upon the milk used. The Tartars add 10 parts of fresh warm milk, in which a little sugar is dissolved, to one part of milk already soured by standing. Fermentation proceeds, by which the sugar is converted partly into lactic acid, and alcohol and carbonic acid are produced. Its use is largely extending. It is nutritious, easily digested, and has some slight stimulating property on account of the alcohol contained in it. Fashion has perhaps as much to do with its employment in cases of disease as any actual benefit derived from it. It is specially extolled in the treatment of consumption.

CHEESE.

Percentage Composition of Soft Cheese.

	Camembert.	Neufchatel, fresh.	Roquefort.	Brie.
Water........	51·94	37·87	34·5	51·87
Nitrogenous	18·90	17·43	26·5	18·30
Fat............	21·05	41·30	30·0	24·83
Sugar.........	3·40	—	4·0	—
Salts..........	4·71	3·40	5·0	5·0

Percentage Composition of Hard Cheese.

	Cheddar.	Dunlop.	Gloucester, single.	Gloucester, double.	Stilton, fresh.	Gorgonzola.	Gruyère.	Parmesan.	Skim-milk.	American.
Water	27·83	38·46	21·41	34·3	32·18	43·56	34·68	27·56	48·02	30·13
Nitrogenous	44·47	25·87	49·12	29·2	24·31	24·17	31·41	44·08	32·65	33·81
Fat.............	24·04	31·86	25·38	29·6	37·36	27·95	28·93	15·95	8·41	32·88
Sugar..........	—	—	—	2·0	2·22	—	1·13	6·69	6·80	—
Saline..........	3·66	3·81	4·09	4·9	3·93	4·32	3·85	5·72	4·12	3·18

Cheese is chiefly the curd of milk, containing also a proportion of fat, entangled in the curd, varying in quantity according to the quantity of fat present in the milk from which the cheese is made, and a small quantity of the saline constituents of the milk. A small quantity of milk-sugar is present, chiefly in soft cheeses, but it undergoes alteration in process of ripening.

Fresh milk is warmed to a temperature of 80° F., and then rennet, made from the calf's stomach, is added to it along with a proportion of colouring matter, usually annatto.[1] It is allowed to stand for an hour, by which time the curd has formed. The curd is then cut up into small pieces and the whey poured off. Some of the whey is heated and poured over the curd to scald it. The curd is then removed, put into a vat, and placed under a press to expel the whey. The curd is thereafter broken up again and mixed with salt, two pounds of salt to the hundredweight of curd. The cheese is then pressed in a mould. It is then bandaged with cloths, removed from the mould, placed aside, and turned daily for five or seven days. It is then removed to the shelf of a room, kept at a temperature of 75°. It is daily turned, greased and polished, and after three or four months is ready for use. Large factories, fitted with all sorts of mechanical contrivances for carrying on the process of cheese-making, now exist, especially in America, and the cheeses they produce are of a more uniform quality. While rennet is usually employed, acid—vinegar—and other agents for curdling, may be made use of, and cheese may be made from sour milk without the addition of any such agent, the natural production of lactic acid causing coagulation.

The richness of the cheese in fat depends upon the milk used. Whole-milk cheese is made from the fresh milk, without skimming; and examples of this kind are Cheddar, Dunlop, and American. When whole-milk is used with the addition of some cream—the whole-milk of the morning and the cream of the previous evening's milking—a richer cheese is produced such as Stilton. Single Gloucester is made from a mixture of the entire milk of the morning

[1] Annatto is a dye obtained from the pulp, with embedded seeds, of a small South American tree, *Bixa Orellana*. It is very commonly adulterated with turmeric, red earths, red-lead, copper, and other substances. Its use is not to be commended.

and the skimmed milk of the previous evening; double Gloucester is made from entire milk. Neufchatel, Camembert, and Fromage de Brie are cream-cheeses. Roquefort is made from the milk of the ewe, and is kept at a uniformly low temperature during the ripening process, for which purpose the cheeses are kept in subterranean cellars. Skim-milk cheese is poor in fat. Dutch and Parmesan are examples. If the milk has been skimmed twice a very poor cheese is obtained. There is a very hard kind of cheese produced in Suffolk from milk skimmed several times, concerning which it is said that it often requires an axe to cut it, "that pigs grunt at it, dogs bark at it, but neither of them dare bite it."

From 9½ to 10 pounds of milk are required to make 1 pound of whole-milk cheese—that is to say, about a gallon of milk yields 1 lb. cheese. One cow will yield from 3½ to 4 cwt. of cheese per annum.

In the ripening of cheese various chemical changes occur, which make the cheese more readily digested than when it is fresh. Both the curd and the fat undergo changes of a fermentive kind. By the same process the peculiar flavour of the cheese is developed. In the process of ripening a mould appears, common vegetable fungoid growths developed from spores that have gained entrance to the cheese in course of manufacture. These vegetable moulds grow at the expense of the substance of the cheese, and therefore diminish its absolute nutritive value. On the other hand, they add to its flavour and its digestion, probably to some extent mechanically by the fine veinlets of mould permitting the cheese more readily to crumble down and be attacked in smaller particles by the digestive fluids. The cheese-mite, or *Acarus domesticus*, is produced from the eggs of the insect sown in the curd. Cheese-maggots are the larval stage of a fly, the cheese-fly—*Piophila casei*. These may be destroyed by strong heat or immersing the cheese in whisky.

It will be noticed from the tables of composition that cheese is rich in nitrogenous ingredient and fat, whole-milk cheese containing these to the extent of over two-thirds. While this is so, there is a difficulty in making use of these nourishing ingredients from the solidity of the mass, and thus cheese is used rather as a mere adjunct to food than for its nutritive value. Cream-cheeses are usually more easily digested, because the large proportion of fat makes them crumbly and more easily broken down. When cheese, however, is mixed with other food-stuffs, as with corn-flower, bread, &c., when grated to form cheese-pudding, these ingredients separate up the cheese particles; and then a quantity may easily be taken—sufficient to be of considerable nutritive value. Such additions also make up what is deficient, indeed practically wanting in cheese, the starchy or sugary element. It may further be noticed that the saline constituents of cheese are rich in phosphates, of value in bone formation. In a sample of double Gloucester of a total of 4·9 per cent salines, phosphates contributed 3·1.

Various Animal Foods Compared.

It will now be of interest and value to compare the relative richness in nutriment of the various animal foods we have considered. For that purpose I shall place alongside of one another the composition of the chief kinds of such food from the tables already given:—

	Lean Beef.	Bacon.	Fowl.	Egg.*	Cod.	Milk.	Cheese (Cheddar).
Water	72	13·9	73·15	71·7	77·5	86·87	27·83
Nitrogenous	19·3	9·0	22·65	14·0	18·5	4·65	44·47
Fat	3·6	74·1	3·11	11·0	3·0	3·50	24·04
Sugar	—	—	—	—	—	4·28	—
Saline	5·1	3·0	1·09	1·3	1·0	0·70	3·66

* 2 per cent of extractives and membranes omitted.

If we exclude water and salines then from the above tables, we find that 100 parts of each food-stuff contain of nourishing materials the following amounts:—

Beef, ...	22·9	Cod, ...	21·5
Bacon, ...	83·1	Milk, ...	12·43
Fowl, ...	25·76	Cheese, ...	68·51
Egg, ...	25·0		

This shows that beef, bacon, fowl, egg, and cod come very near to one another in the proportion of nourishing material they contain. Cheese stands high in the list, but it is really in a different class from the others, because it cannot be eaten in any quantity, and is really a food adjunct, and cannot take the place of a chief article of diet. Allowing, then, for variations in composition, we may say that, weight for weight, beef, bacon, fowl, egg, and cod are comparatively nearly of equal nutritive value, considering the total nutriment each contains. Considering the details of the composition, we see how alike beef, fowl, and cod are, and how one could readily take the place of the other in a diet, without any deficiency in a particular ingredient arising from the change. It is specially interesting to note how completely fish may

take the place of beef; and, when we remember the marked difference in price between the two, this is a point worthy of being brought markedly into prominence. It is an irresistible plea for the more extended use of fish in the diet of the people. Bacon heads the list; but the small proportion of nitrogenous material and the excess of fat exclude it from entering into serious competition with the other three, though it is nevertheless a highly valuable food-stuff. It is evident also that egg occupies a similar platform to beef, fowl, and fish, and at any rate does not possess any marked pre-eminence. It has no right to be considered, as it so commonly is, a concentrated food-stuff.

II. Non-Nitrogenous Animal Foods.

BUTTER AND BUTTER SUBSTITUTES, LARD AND DRIPPING.

Percentage Composition of Butter and Oleo-margarin.

	Butter.	Oleo-Margarin.
Water	9·40	10·50
Nitrogenous (Curd).	1·40	—
Fat	86·50	87·00
Milk-sugar	·80	0·70
Saline	1·90	1·8

Butter, though consisting mainly of milk-fat, contains a small proportion of the other ingredients of milk. Butter may be made directly from the sweet milk, but usually is made from cream. Rather more butter is obtained from the whole milk, but the process is more laborious, because of the large bulk of fluid. It takes about 23 pints of milk to yield 1 lb. of butter. A good cow will yield 8 to 12 lb. of butter a week during the season; and well-selected cows will yield on an average 2 to 2¼ cwt. of butter per year. The milk is placed in shallow pans and kept at a temperature of about 60° F., at which temperature the cream rises best. Once or twice in twenty-four hours the cream is removed, and placed in a crock till sufficient has been collected. Sometimes annatto is added to it to give a colour, or grated carrots are steeped in it and strained out next morning for a like purpose. In large establishments for the manufacture of butter, the cream is now separated by centrifugal machines. Owing to the keeping the cream becomes slightly sour, because of the change of some of the milk-sugar into lactic acid. This facilitates the separation of the butter, though butter made from sweet cream has a pleasanter taste, and is said to keep much longer. The cream is then placed in a churn, of which there are many forms. Whatever their form, the purpose is the same, namely, by mechanical agitation of the milk globules to break the fine film of albumin which surrounds them, and thus to permit the escape of the oil. The fat thus released runs together, and lumps of butter are produced. The cream is put into the churn at a temperature of about 60° F., at which it is kept. The churning process occupies from thirty to forty-five minutes. The butter is then collected, washed in cold spring-water, to rid it as much as possible of the other elements of milk, and is then kneaded to express the water. It is thereafter mixed with salt as a preservative. In fresh butter there is always added salt to the extent of ½ to 2 per cent. Salt butter contains from 3 to 6 pounds of salt to every 112 pounds of butter, and if it is to be kept for an unusually long time a little sugar is added, not exceeding 8 ounces to every 112 pounds. During the whole process great care requires to be taken to ensure the cleanness of the vessels, churns, &c. used, and of the atmosphere in which the butter is kept. For butter very readily acquires a change of flavour from odorous or smelling substances in its neighbourhood, as well as from any highly-flavoured food eaten by the cow. While the above table gives a fair average composition, very varying results are obtained from different samples. The quantity of curd, milk-sugar, and water will depend upon the care and thoroughness with which the butter has been washed and pressed. An increase in the quantity of curd present diminishes the keeping quality of the butter, from the tendency of the curd to undergo decomposition. The milk-sugar and curd are present in too small quantity to impart any nutritive quality of any consequence apart from the fat.

There is a simple method of making a rough estimate of the quantity of the three chief constituents, which will aid in determining the quality of any particular sample of butter. Place some butter in a test-tube, and melt it by immersing the tube in warm water. As soon as the butter becomes liquid, it will separate into its chief constituents, a layer of water at the bottom, a layer of oil on the top, and between the two a ring of curd. The water should form little more than an eighth of the total liquid in the tube, the oil should form the remainder, the ring of curd being of no marked extent. Any adulteration with water would be quickly detected by such a simple method as this, and any excess of salt would also be noticed. Butter fat is a very complex substance. It is a mixture of various fats, the chief being olein,

stearin and palmitin, and butyrin; while, in small quantity, there also exist other fats, called caproin, caprylin, and rutin. Each of these fats is a chemical compound of a fatty acid and glycerin. Thus oleic, stearic and palmitic, and butyric acids are the acids which, in combination with glycerin, yield the fats olein, &c. The oleic, stearic, and palmitic acids do not dissolve in water, but the others do dissolve. Now sometimes a bad flavour is formed in butter by the decomposition of the butyrin and caproin into their respective fatty acids. These being soluble, the bad flavour may be removed by washing the butter.

In 100 parts of butter-fat the proportion of the several fats is as follows:—

Olein	42·21
Stearin, Palmitin	50·00
Butyrin	7·69
Caproin, Caprylin, Rutin	0·10

Although the last four fats exist in comparatively small quantity, it is they which give to butter its peculiar flavour, distinguishing it at once from other animal and vegetable fats, and it is on the quantity of these last four that analysts mainly depend for distinguishing between pure butter and manufactured substitutes, as will be seen from the analysis given below of the fat of oleo-margarin.

Oleo-margarin, margarin, or **butterine** are various names given to articles manufactured from various animal fats as substitutes for butter. The process is briefly as follows:—Beef fat is principally used. It consists chiefly of stearin, margarin, and olein. It is melted by means of hot water, when the animal fat separates as a yellow oil, water and solid particles sinking to the bottom. A scum of impurities forms on the surface, which is removed, and the oil is run into troughs, where it is kept till much of the stearin crystallizes out. The oleo-margarin is afterwards removed and filtered through cotton, the separated stearin being afterwards used for the manufacture of candles. The oleo-margarin is put into a press and then churned with milk, it being itself quite tasteless, to give it the flavour of butter. It is next coloured, and, after rolling with ice, is packed for use.

As will be seen from the table the composition of oleo-margarin does not differ materially from that of butter. It is indeed a matter of difficulty for experts to distinguish well-made oleo-margarin or butterine from pure butter. Chemists agree in declaring wholesome butter substitutes to be as valuable a food-stuff as pure butter, and to be really not one whit inferior. Its cheapness brings it within the reach of many who find it difficult to purchase the real article. The prejudice against its use is not justified. It is, unfortunately, too often the case that butterine is sold as real butter, and at, or nearly at, the price of the native product. If the people would put prejudice aside, and instead of buying inferior kinds of butter, be not ashamed to buy good quality of butterine or oleo-margarin, they would get an article not easily distinguished from the best butter, at a much more moderate cost. Legislation, instead of hampering the manufacture and sale of these butter substitutes, is now endeavouring to secure that butter substitutes shall not be sold under the name and at the higher price of butter. Chemists distinguish between pure butter and butter substitutes by the proportions of the various fats in each. The fat of oleo-margarin contains:

Olein	30·4
Stearin	46·9
Palmitin	22·3
Butyrin, Caproin, Caprylin	0·4

The marked deficiency in the last three fats as compared with their amount in true butter is evident by comparison with the table of composition of butter-fat given above.

Lard is the fat of the pig melted out from the tissue of which it formed a part. This is done by cutting up the fatty tissue into small pieces and placing them in vessels, usually made of iron, heated by steam. As the fat melts, any water and debris fall to the bottom, and other impurities rise to the surface. The pure lard is run off into bladders or kegs. Pure lard should have no smell and almost no taste, and should be quite free from colour. It usually contains nearly 10 per cent of water, though by various methods it may be made to take up a much greater quantity than this. Smith states that lard should contain 8,237 grains of carbon per pound, the hydrogen it contains being reckoned as carbon (see p. 532).

Dripping is fat obtained in the process of roasting flesh. It is almost a pure fat, and differs from lard mainly in the flavour it has derived from the meat. Both lard and dripping are highly valuable as energy-yielding food-stuffs.

THE COMPOSITION OF VEGETABLE FOODS.

I. Nitrogenous Vegetable Foods.

THE CEREALS OR GRAINS.

Average Percentage Composition of Grains.

	Wheat.	Oats.	Rye.	Barley.	Indian Corn or Maize.	Rice.	Millet.	Buckwheat.	Dhurra, Indian Millet.
Water	13·56	12·92	15·25	13·78	13·88	14·41	11·26	13·4	12·2
Nitrogenous	12·42	11·73	11·43	11·16	10·05	6·94	11·29	15·2	8·2
Fat	1·70	6·04	1·71	2·12	4·76	0·51	3·56	3·4	4·2
Starch, Sugar, &c.	67·89	55·43	67·83	65·51	66·78	77·61	67·33	63·6	70·6
Fibre	2·66	10·83	2·01	4·80	2·84	0·08	4·25	2·1	3·1
Saline	1·77	3·05	1·77	2·63	1·69	0·45	2·31	2·3	1·7

With one exception all the substances mentioned in the above table belong to the natural order of the grasses (*Graminaceæ*). The term "cereals" is employed to include them, meaning the fruit of such grasses as are used for food. Buckwheat is not a grass, but belongs to the same natural order as rhubarb and dock (*Polygonaceæ*). It is used pretty much as are the grains, and, therefore, we may consider it here.

The nutritive value of all these substances is clearly evident from the above table. The analyses of the first seven are from a German source (Kœnig), and represent the average of several hundred analyses; the last two are from an English source (Church).

If we leave out the water, the fibre, which is non-digestible, and the saline constituents, then we find that some of these seeds contain as much as 85 parts (rice) of nourishing material in the 100, while only barley and oats fall below 80 per cent. In regard to oats, I do not think the table above does it justice. Its total nutritive material is represented as falling as low as 73 per cent. Nowhere are oats used so largely or grown to such perfection as in Scotland, and the above table is not a fair representative of good Scotch oats. But I preferred to give the analyses as nearly as possible all from the same authority, to make comparisons more fair, and therefore have not substituted another analysis in this case in place of Kœnig's. An analysis of six samples by Fehling gave from 80·93 to 82 per cent of nutritive material. Without doubt the finest qualities of oats contain an excess of nutritive material over that of the finest English wheat.

When the details of the composition are examined some very interesting facts are brought out. They all contain both the tissue-repairing and the energy-yielding kinds of food-stuffs. In all of them the energy-yielding food-stuffs, starch, sugar, and fat specially abound, though the tissue-repairing material (nitrogenous) is in very good proportion. According to the above table the following is the order of richness in nitrogenous or proteid substances:—

Buckwheat.
Wheat.
Oats.
Rye.
Millet.
Barley.
Maize.
Dhurra.
Rice.

The following is the order of richness in fat:—

Oats.
Maize.
Dhurra.
Millet.
Buckwheat.
Barley.
Rye.
Wheat.
Rice.

The following is the order of richness in carbohydrates (starch, sugar, &c.):—

Rice.
Dhurra.
Wheat.
Rye.
Millet.
Maize.
Barley.
Buckwheat.
Oats.

If we take all three nutritive materials, then, of the ordinary grains used as food oats and wheat rank highest, and, considering the finest qualities, oats have the pre-eminence.

Wheat is an annual grass, of which there are several species. That commonly grown in England is *Triticum vulgare*, of which there are two varieties—summer and winter wheat (*Triticum æstivum* and *T. hybernum*). It is culti-

vated in nearly all temperate climates, but more in the northern than southern hemispheres. It varies much with the soil on which it is reared, and with the dryness or wetness of the season. There is the hard wheat, such as is grown in Odessa, Africa, and Egypt. It is horny and semi-transparent in appearance, is specially rich in nitrogenous or proteid material, and less rich in starch than the average shown in the above table. It is from such kinds that macaroni and vermicelli are prepared. The soft or white wheat is more tender and floury, is more easily ground, contains more starch and less nitrogenous material, and makes a finer flour. There is an intermediate variety grown in France.

Wheat, as supplied to the miller, is deprived of its husk. The seed consists of an outer portion, formed of a series of coverings or membranes, and of an inner part, the substance of

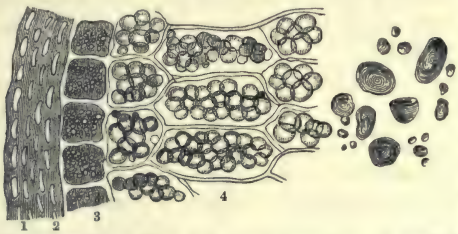


Fig. 194.—Section of Wheat Grain—highly magnified. To the right the granules of wheat starch are shown more highly magnified.

1 indicates the outermost seed-coat, formed of several rows of thick-walled cells, 2 is an inner fine seed-coat, and 3 are called the gluten cells where the cerealin is found. All these yield the bran. 4 points to the compartments filled with starch grains.

the seed itself, divided off into compartments in which are starch grains. The figure (Fig. 194) shows these different parts when a thin slice, taken across a grain of wheat, is examined under a highly magnifying microscope. The various coverings are removed in the process of grinding and dressing for flour and form the bran, while it is from the starchy centre that the fine flour is made. The branny coatings are specially rich in nitrogenous material, though the starchy centre is not by any means devoid of it, the compartments in which the starch grains lie being formed of albuminoid material. It appears that the innermost layer of the seed covering (3 of Fig. 194) is richest in albuminoid material. In this coat there is also present, it appears, a ferment (cerealin) capable, under proper conditions of heat and moisture, of converting the starch of the grain into sugar.

Whole wheat is hardly at all used for food; but it once made a popular dish in England, called **frumity or furmenty**, which is still occasionally seen in Yorkshire. It was a common dish in harvest-home celebrations. In its preparation new wheat was steeped in water in a pan, placed in the oven and kept at a temperature of about 120° Fahr. for some eighteen to thirty-six hours. Not only did the grain swell in the process, but by the heat and moisture the ferment was enabled to act upon the softened and ruptured starch grains, converting them into sugar. The grain was then boiled with milk; and sweetening and spice were added. It is said to be a delicious dish, but the presence of the husk and bran made it indigestible.

By the grinding of wheat various products are obtained. The whole grain may be ground as finely as possible, no part being removed. Modern methods of milling now make it possible for very much finer whole meal to be placed in the market than formerly. Some of the objections to whole meal have thus been removed. The branny portions are not easily reduced to a fine condition, and if they are present in the meal in particles of any size, not only are they indigestible, but their roughness and their sharp edges irritate the bowels, and so stimulate them as to cause the food to be hurried along the bowel before the nutritive material can be extracted from it. Indigestible themselves, they thus also prevent the due digestion of other food. The grinding of wheat has now, however, become a very elaborate process, and in mills, constructed and furnished in the most approved fashion, a very large variety of products is obtained from the wheat. The wheat is passed between rollers, in which it is submitted to a cracking and squeezing action, the purpose of which is to enable the kernel to be separated from the other coverings. It is passed through a series of rollers, five, six, or seven, being submitted between each "break" to a series of sifting and winnowing and dressing operations, by which branny particles are separated out, and the flour which the "break" has produced is sifted out, the intermediate portion being passed on to the next roller, and so on. Thus, after it has passed through two or three rollers, branny portions have been largely removed, and the product is white and granular, consisting chiefly of the kernel of the grain broken up into coarser or finer particles, according to the exact number of rollers through which it has passed. To this product of the wheat, in its conditions of coarse or fine particles, the name **semolina** is given. By further operations of rolling, dressing, &c., it may be reduced to the form of flour. Various terms are applied to the differ-

ent products obtained in the various stages of the milling process. A simple division of the products is into flour, middlings, and bran. Of the bran, even, there are many degrees of fineness. Thin bran is that part of the covering which is often separated before the grain is broken according to one method, that of Mège Mouriés, by damping and rubbing the grain. Then there is long bran, the next outermost coat of the grain. Pollard is a finer bran. Middlings consist of fragments of the kernel of the grain mixed with branny particles, and as they are submitted to further rolling they become reduced and separated by winnowing, &c., from the branny portions. Tailings is a term applied to lighter portions of the wheat, separated out by winnowing, consisting of parts of the kernel adhering to the bran, which, by subsequent breaking, become separated, so that finally the tailings become reduced to simple bran. Sharps is the product a stage behind the fine flour, in which the starchy part of the grain is yet in particles, and in which some of the outer parts of the seed are still present, though in a fine state of division. Fine sharps is also called seconds flour, and coarse sharps thirds. It is worth noticing those different varieties, because their chemical composition is different. The chief difference consists in the varying proportion of nitrogenous material which each contains. As already noted, the outer parts of the grain are richest in nitrogenous or albuminoid material, and the kernel is richest in starch. Accordingly, as the coarser portions are removed, and the stage of fine white flour is reached, the proportion of albuminous material falls, and that of starch rises, so that the finest white flour, consisting essentially of the heart of the grain, is poorer in tissue forming and repairing material than the inferior qualities of flour, in which a larger proportion of the outer parts of the wheat is present. This is well shown in the following note, taken from Church, of the relative proportion of the nitrogenous material in one pound of some of the products named:—

				oz.	grs.
1 pound of finest flour contains of nitrogenous			material,	1	297
,,	middlings	,,	,,	2	105
,,	coarse sharps	,,	,,	2	246
,,	fine pollard	,,	,,	2	210
,,	long bran	,,	,,	2	182

In the outer parts of the grain, also, the saline constituents reside in greatest abundance. Thus they amount in fine flour to 50 grains in the pound, in middlings to 147 grains, in fine pollard to 399 grains, and in long bran to 1 ounce 60 grains. Much of the saline material consists of phosphates, of great value in the formation of bone. Thus a seconds flour is superior to the finest quality from a nutritive point of view, because of the larger proportion of material useful for the repair of all the tissues and the formation of bone. It might also be said, at least so far as the chemical composition is concerned, that a still lower quality of flour possessed a higher nutritive value. But when one takes coarser kinds, the element of digestibility enters into the question. It has been shown, by direct experiment, that when bread made from the finest flour was consumed, less was expelled from the alimentary canal in the form of waste than when bread of coarser qualities was eaten. It is not possible, therefore, to make the chemical constitution the only test of the nutritive quality of the flour. The following table shows the differences that have been indicated:—

	Fine Flour.	Whole Meal.	Bran.
Water	13·0	14·0	14·0
Nitrogenous	10·5	21·8[1]	15·0
Fat	0·8	1·2	4·0
Starch, Sugar, &c.	74·3	59·7	44·0
Fibre	0·7	1·7	17·0
Ash	0·7	1·6	6·0

[1] Of which a large portion is not useful for nutrition.

Flour consists, it appears from the table, to the extent of three-fourths of starch, and contains only a tenth of nitrogenous material, with less than a hundredth part of fat. The starch may be separated from the nitrogenous material by a comparatively simple process. The flour, made into a stiff dough with water only, is placed on a sieve or on a piece of muslin tied over the mouth of a wide bowl, and worked with the hand while a stream of water flows upon it. The starch granules pass through the muslin or sieve with the water, and the process is continued till all the granules have been washed away, and the water passes through quite clear. The starch may be recovered from the bowl by decanting the water, as it does not dissolve in cold water, and then drying it. There remains on the muslin a yellowish, semi-transparent, adhesive substance, somewhat elastic, to which the name **gluten** is given. When dried it is a horny, brittle substance. This may be made without further preparation into small rolls or buns and baked in the oven, when one has **gluten bread**. It swells greatly during

baking, so that very small pieces are used for each roll. It is this bread which is used in the treatment of diabetes (p. 303), in which all sugar is cut off from the dietary, and necessarily also all starch, since starch is converted into sugar in the body. There is no grain other than wheat which yields a flour containing so much gluten. It is the presence of the gluten that enables wheat flour to be so readily made into a dough, which can be baked into loaves. Its adhesive and ductile qualities render it possible to bake it into various forms which will retain the shape given to them. But this gluten, or vegetable albumin, as it is also called, is not a simple substance like egg albumin. It appears to consist of no less than four albuminous bodies. One of these is gliadin, "which is like a clear yellow varnish, and so tenacious that it may be drawn into threads." So that it is this constituent of the gluten specially which gives the tenacious character to dough.

Bread is simply baked dough, made with flour and water, a porous or spongy character having been given to the mass. This spongy character is produced by a variety of methods. The one in ordinary use is that of fermentation, and consists in the introduction into the dough of some yeast, which in course of its activity produces alcohol and carbonic acid gas. If the yeast has been thoroughly mixed with the dough the carbonic acid gas is produced uniformly throughout the mass, and thus causes the dough, because of its tenacious character, to rise with the pressure of the generated gas, and to be permeated by a multitude of minute spaces. The gas escapes from the bread, but the fine spaces or cavities remain permeating the bread and conferring a porous character upon it. The nature and action of yeast are described in the next section, in the portion devoted to the consideration of the manufacture of alcohol. Various kinds of yeast are used for this purpose. Barm is the yeast used by brewers to excite fermentation for the manufacture of beer, and is used by some to produce the best-flavoured bread. Leaven is obtained from old dough. If a paste be made of flour and water, and set aside in a warm place, fermentive changes will arise in it, and if a portion of this dough be mixed with fresh dough it will excite the change quickly in the latter. The cause of the fermentive change is really the same in leaven as in yeast, the action of the yeast plant, which in the former case has been deliberately introduced, and whose introduction has in the latter case been left to chance. The leaven is, on that account, apt to become the scene of abnormal forms of fermentation of an acid kind, and to produce a souring action on the dough rather than a true leavening action. Bakers' yeast is a preparation of boiled and mashed potatoes to which yeast and flour are added, the potatoes affording nutriment for the growth of the yeast. Patent yeasts are now extensively employed. They are produced by scientific methods from malted grains, as in the production of alcohol; mixed with starch and filtered, the yeast can be pressed into cakes, in which form it is easily kept and transported. Such yeasts are imported principally from France, Germany, and the Netherlands.

In the making of bread a portion of the flour is mixed with the ferment with water and salt. The mass produced is set aside, and forms the "sponge." It is left for several hours, during which fermentation occurs and the sponge rises, and latterly collapses by escape of gas. Thereafter the remainder of the flour, with additional salt, is incorporated with the sponge, forming the dough, which is thoroughly kneaded. It is then allowed to lie for a couple of hours longer, when it is turned out of the trough, and weighed out into the required masses, which are shaped into loaves for the oven. With the heat of the oven the gas, entangled in the dough, expands and causes a further "rising" to take place; and with the continuance of the heat the yeast is killed, so that no further fermentation can occur. The dough can be made porous by other methods not involving fermentation. Tartaric acid and carbonate of soda mixed with the dough will cause it to rise, because the chemical action of the two produces carbonic acid gas, which expands the bread. This process was devised by Dr. Whiting in 1836. He, however, used hydrochloric acid added to the water, the carbonate of soda being mixed with the flour. In 1845 tartaric acid was substituted for hydrochloric. Baking-powders are made of mixtures of tartaric acid and soda, and sometimes they are coloured yellow with turmeric and called *egg-powders*, though they are quite innocent of any acquaintance with eggs. Another method of raising bread was patented by Dr. Dauglish in 1856. It consists in making the flour into dough with water charged with carbonic acid gas, and the bread produced was on that account called "aerated bread." The carbonic acid gas is produced first, and is dissolved in water under pressure, a simple aerated water being produced. In another strong iron vessel called a "mixer" the

flour is made into dough with the aerated water by the action of "arms" worked by machinery. The gas passing off from the water permeates the bread, and when the dough shaped into loaves is turned out of the machine, it expands still further. During the whole operation it is untouched by the hand. From the absence of the chemical changes occurring in fermented bread, the flavour is not so complex, nor so enjoyable, as that of the fermented variety. The addition of carbonate of ammonia to dough will also cause "rising" to occur by the production of vapour of ammonia, owing to the heat, and its dissemination through the dough. It will be noticed that whatever method is employed, the chief result desired is that of permeating the bread with air spaces to confer lightness and sponginess upon it, and render every particle of it more easily accessible to the action of the digestive fluids, and therefore more readily digestible.

There are considerable chemical differences between ordinary bread and the flour from which it is made, changes produced by the process of baking, and the changes set up by the fermentation. The baking causes the starch grains to swell and burst, rendering their contents accessible to the digestive fluids. The albuminous substances are coagulated, and can no longer be separated from the starch. Some of the starch is changed into dextrin, a form of sugar, by the action of heat, and this specially occurs in the crust. Some of the starch will also be converted into sugar by fermentive changes which occur if the flour contains any of the cerealin of the grain. Bread contains, therefore, always more sugar than is present in flour. While the bulk of alcohol produced by the process of fermentation escapes, an appreciable quantity can always be detected in fresh bread. "A pound loaf would yield, if very carefully distilled, about twenty-two grains (considerably less than a tea-spoonful). As the bread gets staler the quantity decreases." The following table shows the composition of fine white bread:—

	Fine White Bread.
Water	38·51
Nitrogenous	6·82
Fat	·77
Starch, Sugar, &c.	52·34
Fibre	·38
Saline	1·18

The amount of water present in bread should not exceed that stated in the table. But supposing flour were made to take up more water than usual, it is evident that a larger quantity of bread than usual could be produced from a given quantity of flour, to the profit of the baker. This is one of the chief reasons for the adulteration of bread with alum, rice, &c. Dr. Letheby says, "in practice 100 pounds of flour will make from 133 to 137 pounds of bread, a good average being 136; so that a sack of flour of 280 pounds, should yield 95 four-pound (quartern) loaves. The art of the baker, however, is to increase this quantity, and he does it by hardening the gluten through the agency of a little alum, or by means of a gummy mixture of boiled rice, three or four pounds of which will, when boiled for two or three hours in as many gallons of water, make a sack of flour yield 100 four-pound loaves. But the bread is dropsical, and sets soft and sodden at the base, where it stands." The method of detecting these adulterations is mentioned on p. 597.

Bread loses weight by evaporation of water. The 4-lb. loaf loses on an average

In the first	24 hours	1¼ ounce.
,,	48 hours	5 ounces.
,,	60 ,,	7 ,,
,,	70 ,,	8¾ ,,

—(Blyth.)

Bran bread, and specially whole-meal bread, show a larger proportion of nitrogenous constituents, but for reasons already stated, it is not likely that it yields any appreciably larger quantity of nourishment to the body, though for many persons its action on the bowels is of considerable value.

Malted bread is bread prepared with malt, by means of which a considerable quantity of the starch of the flour is converted into sugar, and by this means the digestive organs are relieved of some of the work they would otherwise be called on to perform.

Biscuits are usually unleavened. The simplest sailors' biscuits, for example, are made with flour and water, and with, perhaps, a slight addition of butter. Fancy biscuits are made with special qualities of flour, and contain, besides the ordinary ingredients, milk, salt, butter, sugar, perhaps eggs, and any special flavouring or colouring agent. They are sometimes "lightened" by means of carbonate of ammonia. Because of their dryness they keep well. They are as a rule exceedingly wholesome, and contain more nutriment than an equal weight of bread. Biscuit powder boiled with milk, or a mixture of milk and water, and slightly sweetened is a useful food for infants. Tea

biscuits ground by means of a rolling-pin may be used for this purpose.

Passover cakes are a form of unleavened bread. They are made of flour and water only.

Semolina, as already described, consists of the heart of the wheat grain in a yet granular condition. It is largely starchy in composition, and is not, therefore, suitable as a main article of diet. It is, however, usually made from the hard wheats of warm climates, and thus contains a larger quantity of nitrogenous constituent than that made from ordinary white wheat.

Macaroni, Vermicelli, and Cagliari Paste are also prepared from the hard wheat. A paste is made of flour and hot water, and is pressed through moulds to produce the pipe form, or stamped out into the desired shape. It is then dried. Such preparations of wheat contain a much higher proportion of nitrogenous material than bread. They are exceedingly nourishing in consequence, if less digestible because of their close texture.

Oats are derived from an annual herbaceous grass, of the tribe *Aveneæ*. The common oat

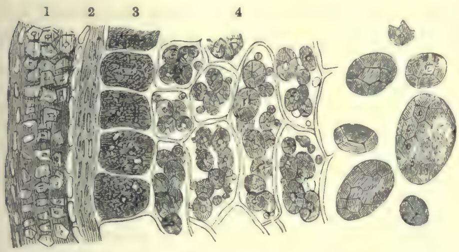


Fig. 195.—Section of Oat Grain—highly magnified. 1 and 2 are the membranes enveloping the seed, corresponding to the bran of wheat. 3 is the surface layer of the seed itself. 4 are the compartments containing starch granules, into which the substance of the seed is divided. To the right of the fig. are shown some of the granules of starch from the interior, more highly magnified.

is derived from the *Avena sativa* or *orientalis*. It is a hardier plant than wheat, ripening well in colder climates. Grown in England as food for horses, it was long the main, and in a large number of cases the only, food of the Scotch peasant. A bag of oatmeal was the only ration the Scotch clansman provided himself with, when he sallied forth with his clan to a fray, and the Scotch Highlanders have been considered as one of the most martial and enduring races on record.

Fig. 195 shows a section of the oat grain, resembling that of wheat, the kernel consisting of compartments filled with starch grains, and being surrounded by several coats richer in nitrogenous material. The husk adheres to the grain very closely. For its removal the grain is dried on a kiln, and then by grinding in a mill the grain is broken up, and the husks removed. The oat broken up into coarse particles is called groats or grits, these on being ground form oatmeal. One hundred pounds of oats yield of—

Oatmeal	60 pounds.
Husks	26 ,,
Water	12 ,,
Loss	2 ,,

The composition of a fresh sample of Scotch oatmeal, which possesses the largest nutritive properties, is shown in the following table:—

	Scotch Oatmeal.
Water	5·0
Nitrogenous	16·1
Fat	10·1
Starch, &c.	63·0
Fibre	3·7
Saline	2·1

The small proportion of water is noticeable. The nitrogenous constituent consists of two substances, plant casein or avenine, and gliadin. The former resembles in proporties one of the albuminoids of wheat, and in composition the legumin of peas and beans; the latter is in less quantity than in wheat, and thus a dough cannot be made of the flour of the meal, so that oat bread cannot be made. Oatcakes and biscuits are, however, baked, but because of the very slight tenacious character of the meal, they are very short. A very important element in the composition of oatmeal is the large proportion of fat. No other cereal contains such a large quantity; Indian corn is the only other which yields a meal at all approaching to it. It is this, as well as the larger proportion of the nitrogenous material, and the small percentage of water, that makes oatmeal so exceptionally wholesome and nitritious. The salines consist largely of salts of potash and phosphorus.

A fine oat-flour is now prepared by several millers in Scotland, which contains all the nourishing ingredients of the meal. It is as yet sold at too high a price to make it a very extensively used food-stuff. It forms an admirable diet, when boiled with water, for children. It may be given to them with milk as soon as it becomes desirable to supplement the mother's milk, by the sixth or even the fourth month of life, and it may be made an exclusive diet for them up to the end of the eighteenth month, or for any longer time. One often finds it stated that wheat-flour and oatmeal are, weight for weight, pretty nearly on a level as regards nourishing qualities. This is true of inferior qualities of oatmeal. Oats grown in

England, for example, are much inferior in nutritive constituents to the finest Scotch oatmeal. It is not true of the latter, which in point of nourishing constituents, ease of cooking, and digestibility far surpasses every other kind of food-stuff.

The husks of oats with the adherent particles of the kernel are employed to make what used to be a very popular dish in Scotland and South Wales, and called **sowans, seeds,** or **flummery.** The husks are steeped in water for two or three days, till by the action of a ferment, present in small quantity in the coverings of the seed, fermentation arises. The liquid is skimmed and then boiled down to the thickness of gruel. It is called **sucan** or **llymru** in Wales. When it is boiled down for a longer time, it forms a firm jelly on cooling resembling blancmange, which is very light, bland, and nourishing. It is called **budrum. Brose** is prepared by simply stirring in boiling water with the meal. It is eaten with milk. The Scotch farm labourer, with whom it was often the chief if not the only meal, found it more "staying" than porridge because of being less rapidly digested. The water used may be that in which beef has been boiled, and then **beef brose** is the product, or that in which cabbage or kale has been boiled, and the product is **kale brose. Gruel** is made by steeping groats or oatmeal in cold water for several hours, with occasional stirring. The mixture is then well stirred and the water poured off carrying with it the flour of the meal, all large particles being left behind. This liquid is then boiled with constant stirring for 10 or 15 minutes. Milk may be added to it and boiled with it. Sugar, butter, and flavouring agents, such as ginger or raisins may also be added, according to desire. The product is an exceedingly soft, pleasant, and nourishing drink, which is in much favour for the domestic treatment of slight colds in the head, and simple feverish colds, or after hard work and exposure. The common prescription in such circumstances is a hot foot-bath, a gruel, and to bed.

Porridge is made by stirring the meal into boiling water. The water in the pot is allowed to boil first, then a handful of meal is taken, and the meal allowed to fall in a slow stream on to the water, which is continually stirred the while with a wooden stirrer called a porridge-stick or spurtle. From three-quarters to an imperial pint of water and a good handful of meal, about four ounces, are about the quantities to make a good dish for one person. Salt is added to taste. The mixture is kept boiling for fully twenty minutes, by which time the particles of meal have become much swollen and the porridge is thick. Of course it may be made of any desired degree of thickness. The best way to eat it is with cream or milk. Some persons prefer to eat it with butter, or not to add salt and to use sugar, syrup or treacle as an adjunct. But porridge, if properly made, and cream is the dish *par excellence.* The Scot who crosses the border, or the German Ocean, or the Atlantic, and seeks to have his national dish to breakfast, is seldom surprised that its popularity is pretty nearly confined to Scotland. As one finds it served in London or Continental hotels, or in the saloons of Atlantic liners, it is, as a rule, an execrable dish. If properly made few fail to relish and enjoy it. Scotch oatmeal is usually in larger particles than that made in England, and the porridge made from it is usually more enjoyed. Oatmeal is often alleged to be "heating," this view Pereira thinks arises from prejudice and to be without due ground.

Barley belongs to the tribe *Hordeæ* of the grasses. There are several varieties of it. It was originally a native of Western Asia, is hardier than either wheat or oats, and may be grown in high latitudes. It is used in Britain mainly for the preparation of malt, ales and spirits. In Scotland, in the form of pot or pearl barley, it is used for broth, but not for the making of solid food. On the Continent the meal is added to wheaten flour for bread, and is also largely used alone. It may be used whole after being parched. The grain in section presents an appearance like wheat or oats. The grain ground whole yields barley-meal, and it is also, by a process of rubbing, deprived of its coatings and rounded into the form with which one is familiar. The coarsest form is called pot-barley, and the finest pearl-barley. The composition of barley-meal and pearl-barley is shown in the following table:—

	Barley-meal.	Pearl-barley.
Water	15·06	14·6
Nitrogenous	11·75	6·2
Fat	1·71	1·3
Starch, &c.	70·90	76·0
Fibre	·11	·8
Saline	·47	1·1

Patent barley is made by grinding pearl-barley to powder. Formerly barley-meal was largely employed instead of wheat flour as a food for the people. Its nitrogenous constituent resembles that of wheat. Its salts are rich in

potash and phosphorus. It is both less nourishing and less easily digested than wheat or oats, and is not, therefore, equal to them as a food-stuff. The bread it yields is heavy. **Barley-water** is a pleasant, cooling drink in feverish attacks. It is made as follows: take two ounces and a half of pearl-barley, first wash away with water the foreign matters adhering to the seeds, then add half a pint of water and boil for a little while. This liquid being then thrown away, pour on them four pints (imperial) of boiling water, boil down to two pints and strain. It is frequently flavoured with sugar and sometimes with lemon-peel. (Pereira.)

Malt is produced from barley by causing the grain to germinate by means of moisture and warmth. By the activity of a ferment, contained in the coatings of the seed, some of the starch of the grain is transformed into sugar. This is a process preliminary to brewing, for under the influence of an added ferment—yeast—this sugar is further converted into alcohol and carbonic acid gas. This is described in more detail in the succeeding section.

Rye is derived from the *Secale cereale.* It is grown in the eastern counties of England, mainly for malting purposes. The malt used in the manufacture of Hollands is made from rye. It flourishes in soil too poor for wheat. It is extensively used for the production of bread in Northern Europe, the well-known black bread being made from it. Mixed with wheat flour, rye flour is used for the same purpose, two parts of wheaten flour and one of rye flour. The bread is dark and sour and close, though nourishing. The general appearance of a section of the seed resembles that of wheat and oats. Deprived of the husk it is ground into meal and flour. The composition of rye flour and rye bread is shown in the following table:—

Fig. 196.—Spurred Rye.

	Rye Flour.	Rye Bread.
Water	13·0	44·02
Nitrogenous	10·5	6·02
Fat	1·6	·48
Starch, &c.	71·0	47·87
Fibre	2·3	·30
Saline	1·6	1·31

The saline constituents are, like those of the other grains, rich in potash and phosphorus.

It is clear from this table, comparing it with that of wheaten bread, on p. 562, that wheaten bread and rye bread are much alike in nourishing quality, though the former is slightly more digestible. The latter keeps better and does not so quickly become dry and stale.

In Russia rye is used for the production of a fermented liquor called **quass.**

Rye is subject to the attack of a fungus called ergot of rye, or *Secale cornutum,* and the rye attacked is called, from the appearance the fungus produces, spurred rye (Fig. 196). It attacks the ear when it is in flower, the young flower being covered with a white mass, consisting of the spores of the fungus. Ergot is employed in medicine and is an exceedingly valuable drug, but when spurred rye is used for food serious and even fatal consequences are liable to ensue, gangrene of the extremities being produced by the frequent use of the diseased grain. Ergot also attacks wheat and maize.

Fig. 197.—Maize or Indian Corn.
1. The grass. *a a*, Position of the cob. 2, The cob. 3, The corn.

Maize or **Indian Corn** (Fig. 197) belongs to the tribe *Maydeæ* of the grasses, and is called *Zea Mays.* It is native to tropical America, but is now grown also in Africa, Southern Europe, Germany and India. It grows to the height of 6 to 10 feet, the grain growing on a cob, as shown in the figure, several cobs being on each stem. The fruit is in this form called **corn-cob** in America, and is often eaten green, or boiled in milk, or roasted and eaten with other foods. **Pop-corn** is the grain of a small variety of maize burst by the agency of heat. When mature the whole grain may be used after being parched. It is also ground into a meal, skin and kernel together, the coverings

being more easily ground than those of other grains. The grains deprived of the husk and roughly ground yield **hominy, samp,** or **grits,** according to the size of the particles. It needs much boiling, and is the better of being steeped for some hours previous to cooking. The composition of Indian-corn meal is as follows:—

	Indian-corn Meal.
Water	17·1
Nitrogenous	12·8
Fat	7·0
Starch, &c.	60·5
Fibre	1·5
Saline	1·1

It will be noticed from the table that maize meal contains a much larger quantity of nutritive material than all the cereals, oatmeal alone excepted. The quantity of fat present is very high. The nitrogenous ingredient is also abundant, though nearly 2 of the 12·8 per cent is of a kind not available for nourishment to the body. Phosphoric acid and potash are the chief constituents of the saline ingredient.

Maize meal cannot be made into a light bread, but it is cooked in the form of cakes or puddings or prepared as a porridge. Thus in the United States of America a dish called **mush** is prepared from it by boiling. The same in Italy is called **polenta;** a finer meal is termed **polentina. Corn-lob** is a maize porridge made with milk. The brown bread of New England is made of a mixture of maize and rye meal.

Cakes, called **Johnny-cakes,** or hoe-cakes, are made of it and are baked before the fire on a board or on a plate in the oven. In Mexico **tortilla** is the term used for them. They are eaten hot with milk, or butter, treacle, &c.

The objection to maize meal is its flavour, due to the presence of a bitter principle. By various methods of manufacture this principle and the nitrogenous constituents are removed, leaving only the starch of the grain in the form of a fine white powder, called corn-flour, maizena, cornena, Oswego flour, &c. It is really pure starch, and will be considered in detail among the starches.

Rice (*Oryza sativa*) belongs to the tribe *Oryzeæ* of the grasses. It is native to India, and is also grown in China, and the East generally, in Central America, and the southern parts of Europe. It requires a warm climate for its successful growth, and the fields are usually irrigated. There are many varieties, the grains differing in size, colour, and general appearance, that grown in South Carolina being most esteemed. It is cut down and threshed like wheat, and the grains inclosed in the husk are known as **paddy or rough rice.**

The fig. 198 shows a section of the grain. It is the main food of more than a hundred millions of people. It is husked by passing it through a mill, and then the husks are winnowed out, broken rice is separated, and the cleaned kernel is that part sold as rice. Its composition is shown in the table on p. 558, from which it appears to be deficient in nitrogenous material and more than usually rich in starch, and deficient in fat. It is the least nutritious of the cereals, and is not a perfect food alone, because of its deficiency in tissue-repairing material, a deficiency made up by the addition to the diet of some kind of flesh meat, or eggs as in rice-pudding, and to a slight extent by milk. Because of its richness in starch rice is

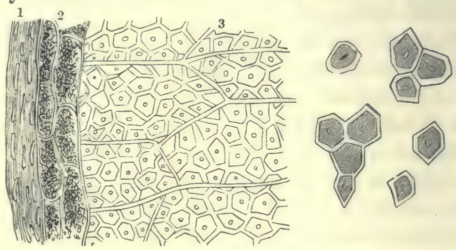


Fig. 198.—Section of Rice Grain—magnified.

1 and 2, Outer coats; 3, Starchy kernel. To the right are seen granules of rice starch, more highly magnified.

used for the production of that article. When cooked alone it should be steamed, not boiled, to prevent the removal of any of the nitrogenous constituents.

Ground rice and rice flour are two products, the latter being often used to adulterate other less cheap kinds of flour, such as that of wheat.

Millet belongs to the species *panicum*, of which there are many varieties. It is native in the East Indies, and is used as food in China and among eastern races, chiefly, that is, in hot countries. The grain is used in this country for feeding poultry and other domestic animals. Its composition is shown on p. 558. Its nutritive value is reckoned as about equal to rice. In the *Lancet* of November 9, 1872, the result of an experiment made with millet is recorded. It was made on a sailor, sentenced to solitary confinement for forty-nine days. He was fed solely on millet and water. "He entered prison on the 3d April, when he weighed 146 lbs. 8 oz., and he left it on the 22d May, weighing 147 lbs. 14 oz. Throughout the confinement he never weighed so little as on the day he commenced, and this in spite of the depressing effects of solitude and the monotony of his food. He ate

about $3\frac{1}{2}$ lbs. of millet daily; and when he left prison he looked, as he said he felt, perfectly well. The experiment shows that the grain, which has been chosen by the people as their principal food, is capable of maintaining for a considerable length of time perfect health under very depressing circumstances.”


Fig. 199.—Millet.

A fermented beverage, called **bouza**, or millet-beer, is prepared from the grain in Tartary, by pouring hot water over a portion of fermented seed. In Sikkim also such millet-beer is in general use. The millet seed is moistened and allowed to ferment for several days. An infusion is then made with hot water, which is sucked through a reed from bamboo jugs. It is said to taste like negus of Cape sherry, rather sour, and though weak a grateful beverage on a hot day's march.

Dhurra, Dhoora, Dari, Sorghum vulgare, or **Sorgho Grass** is a species of millet, Indian millet, but it belongs to a tribe of grasses different from the true millets, namely, *Andropogoneæ*. It is a tall handsome grass which is largely grown in India, Egypt, Algeria, and the interior of Africa, and to some extent in the south of Europe. The grain is white and larger than millet. It is used in this country for feeding cattle and poultry. Its composition is shown on p. 558, from which it appears to be more nourishing than rice, but to contain less nitrogenous material than wheat, though much more fat.


Fig. 200.—Quinoa.

Buckwheat is not a grass, but belongs to the natural order *Polygonaceæ*. It is a native of Central Asia. In France it is called **Saracen wheat**, having been introduced into Europe by the crusaders. In Norfolk and Suffolk it goes by the name of **brank**. It is used in England for feeding game, and sometimes is given to horses. The husk of the seed requires removal before use, and the composition of the grain deprived of the husk is shown on p. 558. It is rich in all the constituents of nitrogenous material, starch and fat. It does not give a tenacious dough for the making of bread, but may, when ground, be cooked as porridge, or made into thin cakes, which is the favourite method of cooking it in America. They are eaten hot with honey or other savoury substance.

Quinoa (Fig. 200) is a seed yielded by a plant, the *Chenopodium Quinoa*, growing in the high table-lands of Chili and Peru. It forms the principal food of the people of the districts where it grows. The order to which it belongs includes the spinach and the beet. It is said by Johnston to be very nutritious, its flour approaching very nearly to oatmeal in composition, and to have formed the chief food of the Peruvian nation. There is a sweet and a bitter variety of it. The meal can be made only into cakes.

LEGUMINOUS SEEDS.

Average Percentage Composition of Peas, Beans, and Lentils.

	Peas.		Broad Beans.		Kidney Beans.		Lentils.
	Green.	Dried.	Green.	Dried.	Green.	Dried.	
Water......	80·49	14·31	86·10	14·84	87·36	13·60	12·51
Nitrogenous (nutritive)	5·75	19·98	4·67	21·30	2·77	20·81	22·31
Nitrogenous (non-nutr.)		2·65		2·36		2·31	2·50
Fat	0·50	1·72	0·30	1·63	0·14	2·28	1·85
Starch, &c.	10·86	53·24	6·60	49·25	8·02	53·63	54·78
Fibre	1·60	5·45	1·69	7·47	1·14	3·84	3·58
Saline......	0·80	2·65	0·64	3·15	0·57	3·53	2·47

The natural order Leguminosæ includes peas, beans, and lentils as the chief examples used as food. They belong to the papilionaceous division of that order, so called from the butterfly appearance of the flower (Latin *papilio*, a butterfly). They are all characterized, as the above table shows, by the unusually large proportion of nitrogenous material, excelling beef, mutton, and fish in this respect, and still more markedly other vegetable products. This is strikingly shown in Plate IX. One must not, however, ignore the fact that this nitrogenous constituent is not all available for nutriment, and that a very much larger proportion of waste attends their consumption than that of animal food. This is further referred to on p. 604. Their richness in nitrogen makes them valuable associates in a diet, abounding rather in starch or fat. As an example of the former take rice and peas or beans, and of the latter, bacon and beans or peas.

Peas. There is the garden pea (*Pisum sativum*) and the field pea (*P. arvense*), the latter grown for feeding cattle. The garden pea is native to the south of Europe. The sea pea (*P. maritimum*) is also used in some parts of Europe as a food. The chick pea or gram (*Cicer arietinum*) is grown largely in the North-western Provinces of India, where it is commonly sown with barley and

wheat. "The tops of the shoots are much relished as a vegetable, the flavour being possibly enhanced by the oxalic acid which it is the curious property of the leaves to exude." It suffers greatly by frost, and is not, therefore, a profitable growth in colder climates. It is also cultivated in the south of Europe.

It will be noticed from the table that peas in the fresh state are much less nourishing than when old and dried. They are, however, much more tender and digestible. The skin is particularly difficult of digestion. The chief nitrogenous constituent of peas, beans, and lentils, is a substance called plant-casein or legumin. It is their richness in legumin that gives them the tendency to produce flatulence and colic, when they are eaten to any extent. The saline constituent is richer in potash and lime than that of the grains, but poorer in phosphoric acid. Peas and other members of the same family contain a bitter principle, removable by soaking in water to which a little ordinary washing soda has been added. It is recommended to soak them in this for some time before cooking, the liquid being thrown away. They require prolonged, slow boiling, even when ground. The tough skin is removed in split-peas. The composition of dried peas ground into meal is stated as follows:—

Percentage Composition of Dried Pea-meal.

Water	8·10
Nitrogenous	28·10
Fat	2·97
Starch	50·17
Fibre	8·12
Saline	2·54

Pease-meal is, subject to the remarks that have been made as regards digestibility, an exceedingly valuable article of diet. Stirred with boiling water to a fine thick paste, and with added salt, it forms brose. But it would be of much greater nutritive value, and milder in action on the stomach and bowels, if made into a porridge, by prolonged boiling in the manner of oatmeal porridge. In Germany a pea sausage and pea tablets are prepared from pease-meal and dried and powdered meat, the mixture being compressed by strong pressure. It has been found a very useful ration for the soldier in campaigning. It contains over 31 per cent of nitrogenous, 3 of fatty, and 47 of starchy material, and 2 lbs. of it daily would supply a diet for hard work. Tinned peas are prepared by being submitted to the influence of a high temperature after being placed in the tins, and then the tins are hermetically sealed. Often they have their colour improved by being previously boiled in copper vessels. Though it has not been found positively that this practice is injurious, it is highly undesirable.

Beans.—The beans commonly used are the haricot, kidney, or French beans (*Phaseolus vulgaris*), and the broad or Windsor bean (*Vicia Faba*). The horse-bean is a variety of the latter. The broad bean is used generally in the fresh state, being grown in gardens, but is also dried and preserved. The haricot bean is a native of India. It is largely grown in Italy and France and was introduced into England in the sixteenth century. The scarlet-runner (*Phaseolus multiflorus*) is a variety of the same plant. It also is used as a green vegetable cooked in its pod. It is native to Mexico, and was introduced into England in 1633.

Haricot beans ought to be a much more popular food-stuff in Britain than they are. With rice or fatty food-stuffs such as bacon they make a well-proportioned and nourishing diet.

"For our labourer," says Sir Henry Thompson, "probably the best of the legumes is the haricot-bean, red or white, the dried mature bean of the plant whose pods we eat in the early green state as 'French beans.' For this purpose they may be treated thus: Soak, say, a quart of the dried haricots in cold water for about twelve hours, after which place them in a saucepan, with two quarts of cold water and a little salt, on the fire; when boiling remove to the corner and simmer slowly until the beans are tender; the time required being about two or three hours.[1] This quantity will fill a large dish, and may be eaten with salt and pepper. It will be greatly improved, at small cost, by the addition of a bit of butter, or of melted butter with parsley, or if an onion or two have been sliced and stewed with the haricots. A better dish still may be made by putting all or part after boiling into a shallow frying-pan, and lightly frying for a few minutes with a little lard and some sliced onions. With a few slices of bacon added, a comparatively luxurious and highly nutritive meal may be made. But there is still in the saucepan, after boiling the haricots, a residue of value, which the French peasant's wife, who turns everything to account, utilizes in a manner quite incomprehensible to the Englishwoman. The water in which dried haricots have stewed, and also that in which green French beans have been

[1] If the water is hard a little soda should be added to soften it.

boiled, contains a proportion of nutritive matter. The Frenchwoman preserves this liquor carefully, cuts and fries some onions, adds to it these and some thick slices of bread, a little salt and pepper, with a pot-herb or two from the corner of the garden, and thus serves hot. . . . But haricots are good enough to be welcome at any table. A roast leg or shoulder of mutton should be garnished by a pint, boiled as just directed, lying in the gravy of the dish; and some persons think that, with a good supply of the meat gravy, and a little salt and pepper, 'the haricots are by no means the worst part of the mutton.' Then with a smooth *purée* of mild onions, which have been previously sliced, fried brown, and stewed, served freely as sauce, our leg of mutton and haricots become the *gigot à la bretonne*, well known to all lovers of wholesome and savoury cookery. Next, white haricots, stewed until soft, made into a rather thick *purée*, delicately flavoured by adding a small portion of white *purée* of onions (not browned by frying as in the preceding sauce), produce an agreeable garnish for the centre of a dish of small cutlets, or an *entrée* of fowl. . . . Let me recall, at the close of these few hints about the haricot, the fact that there is no produce of the vegetable kingdom so nutritious; holding its own in this respect, as it well can, even against the beef and mutton of the animal kingdom. The haricot ranks just above lentils, which have been so much praised of late, and rightly, the haricot being also to most palates more agreeable. . . . I do not, of course, overlook in the dish of simple haricots the absence of savoury odours, proper to well-cooked meat; but nothing is easier than to combine one part of meat with two parts of haricots, adding vegetables and garden herbs, so as to produce a stew which shall be more nutritious, wholesome, and palatable, than a stew of all meat with vegetables and no haricots. Moreover, the cost of the latter will be more than double that of the former."

In China and Japan cheese is manufactured from a species of bean (*Soia hispida*). The beans are ground, made into a paste, and the vegetable casein is coagulated. It contains a little over 3 per cent of nutritive material.

Lentils (*Ervum Lens*) are extensively grown in Egypt, Algeria, Turkey, and the southern parts of Europe generally, and in the East. Esau's pottage is believed to have been made from the red or Arabian lentil, the finest variety. As sold in the shops the seeds are deprived of the husks and split. They also are highly nutritious, as the table shows.

Ervalenta and Revalenta Arabica are mixtures, according to Dr. Hassall, the former of the meal of the French or German lentil with a substance resembling Indian-corn meal, and the latter of the Arabian lentil and barley flour, with the addition of some saline material, chiefly salt. They are sold at a price ridiculously high considering the cost of their ingredients.

TUBERS AND ROOTS.

A tuber is an underground fleshy stem, often considered as a modification of the root. To the class of food-stuffs, tubers and roots, belong the potato, sweet-potato, yam, Jerusalem artichoke, turnip, carrot, beet-root, parsnip, radish, salsify.

The composition of the chief of these, mainly as given by Church, is shown in the following table:—

Average Percentage Composition of Potatoes, Carrots, Turnips, &c.

	Potato.	Sweet-potato.	Yam.	Jerusalem Artichoke.	White Turnip.	Carrot.	Beet-root	Parsnip.	Radish.
Water	75·7	74·0	78·6	80·0	92·8	89·0	82·2	82·0	93·34
Nitrogenous	2·3	1·5	2·2	2·0	0·5	0·5	0·4	1·2	1·23
Carbohydrate (Starch, Sugar, &c.)	19·7	20·2	16·3	14·4	4·0	5·0	13·4	8·7	3·79
Fat	0·3	—	0·5	0·5	0·1	0·2	0·1	1·5	0·15
Fibre	1·0	2·8	0·9	2·0	1·8	4·3	3·0	5·6	0·75
Saline	1·0	1·5	1·5	1·1	0·8	1·0	0·9	1·0	0·74

The large percentage of water in all these food-stuffs at once attracts one's notice, and is graphically shown in Plate IX. Turnip and carrot, in particular, have a very high percentage of water. Radishes resemble carrots in composition. In the next place it is noticeable that all of them are very deficient in flesh-forming and tissue-repairing material. The chief nutriment in them, possessed in greatest amount by the potato, is the carbohydrate ingredient, starch, &c. The proportion of saline ingredients, however, compares very favourably with that of grains.

Even the small amount of nitrogenous material is not all available as nutriment. A considerable proportion of it is found not to be of an albuminoid or proteid character. Thus the 2·3 per cent in the potato consists to some extent of substances belonging to the class of alkaloids, to which class such active principles as quinine, strychnine, etc., belong. Thus, in the potato there is one of them, namely, solanin, which, though nitrogen enters into its composition, is useless for nourishment. Of the carbohydrate element, while the larger proportion is starch, there is a small quantity of sugar, gum, and a substance called *pectin* or *pectose*, formed, like starch, of carbon, hydrogen, and oxygen, but in different proportions, found in most fruits and vegetables, and forming the basis of vegetable jellies. It is evident from the small total quantity of nutritive material contained in such vegetables as carrot, turnip, etc., that they are useful mainly on account of their flavour, and to some extent also because of their saline constituents, and ought to be considered only as agreeable additions to an otherwise plentiful diet.

Potato (*Solanum tuberosum*) belongs to the natural order *Solanaceæ*, the nightshade order, to which such very different plants as the deadly nightshade, tobacco, belladonna, stramonium, henbane, cayenne, and tomato belong. It is an enlargement of the underground stem, and the "eyes" are the buds of this part of the stem, capable of growing independently when detached from the rest. It is native in Chili, Peru, and Mexico, where it is found growing wild, whence it spread to North America. Brought to Europe by the Spaniards early in the sixteenth century, it was cultivated in gardens. In 1565 Sir John Hawkins introduced it into Ireland, and twenty years later Sir Francis Drake brought it to England. It failed to attract much attention, and a year later was reintroduced by Sir Walter Raleigh. It was many years, however, before it was cultivated to any extent, a century elapsing before it was grown in the open fields, and two centuries before it became popular. The name potato is derived from *batata*, the sweet-potato, with which it had been confounded, though the sweet-potato belongs to quite a different order. It grows well in all temperate climates, and it varies much in composition, according, among other things, to the soil on which it is reared.

In 1845 a disease broke out amongst it, dependent upon a fungus, the *Peronospora infestans*, which attacks the lower surface of the leaves and the stalks, having the appearance of brown patches. It appears in July, and penetrates to the tuber.

The substance of the potato is made up of compartments, filled with starch grains in an albuminous juice. In the deeper layer of the skin of the potato pigment is present, and here also the active principle solanin resides. This probably is the foundation for the popular notion that the water in which potatoes in their skins have been boiled is injurious, and ought to be thrown away. Dry heat, however, destroys the solanin, and it exists, in any case, in such small quantity as to be really too insignificant to be productive of any harm. Many people insist on potatoes being pared for a like reason, but they ought to be boiled "in their skins," as this helps to retain some of their valuable qualities. Salt added to the water in which they are boiled helps to prevent the loss of their saline constituents. These constituents are very valuable. Potash is the chief of them, existing to nearly 55 per cent of the total. There are present also some of the organic acids and notably citric. It is probably to the citric acid and potash salts that the potato owes its power for the prevention of scurvy. This power has been amply proved, though to which actual constituent it is due is not positively known. Cooking by steaming is, however, altogether the best way of preventing the loss of valuable ingredients.

Up to the date of the potato famine in Ireland that vegetable was the chief article of diet, an adult Irishman consuming, according to Smith, ten and a half pounds weight daily, three and a half pounds at each meal. For an example of its usefulness in affording a cheap diet see p. 623. As has been already indicated, it is not alone a suitable diet, because of its deficiency in albuminoid material. Beans or peas would supply that want, and butter-milk also. That would, of course, be done most effectually by beef or butcher's meat of some kind.

Starch is manufactured in large quantity from potatoes (see *British Arrow-root*, p. 586), and by permitting fermentation to occur spirit can also be produced, potato spirit, or fusel-oil (see p. 664), British brandy. By roasting, the starch is partly converted into dextrin, by which means British gum is obtained.

Sweet-potato (*Batatas edulis*) belongs to the *Convolvulus* order and is native to the Malayan Archipelago. It is largely cultivated in America, and also in Algeria and Southern Europe, and is grown in Spain and called the

Spanish potato. It was introduced into Spain before the common potato, and was brought to England by Drake and Hawkins, but has not been successfully cultivated, as it requires a warm climate. Its composition is nearly the same as that of the ordinary potato, but it contains 3 per cent of sugar, which the potato does not possess. It varies in size from 9 to 12 pounds in weight, and in Java is said even to attain to 50 pounds. It is a favourite and wholesome food and is said to possess slightly laxative properties.

Yam is also a tuber, belonging to a species of tropical climbing plants, of the genus *Dioscorea* (Fig. 201). Varieties of it are found in the West Indies (*D. sativa*), East Indies, South Sea

Fig. 201.—Yam (*Dioscorea globosa*).

Islands, New Zealand, and Japan and China. It cannot be successfully cultivated in England. It grows to a very large size, one tuber being sometimes 30 to 40 pounds in weight. It is not sweet like the sweet-potato, and its composition is very like that of the common potato (see table). Some species are said to possess poisonous properties.

Jerusalem Artichoke.—This plant belongs to the Sunflower tribe of the natural order *Compositæ*, and its technical name is *Helianthus tuberosus*. The Italian for sunflower is *girasole*, and it is said that in this case Jerusalem is a corruption of girasole. It is not much used in Britain, though it was cultivated in Europe before the potato, and was introduced into England from Brazil in 1617. It is a native of Mexico. The portion used as food consists of oval or rounded masses which form round the root. The carbohydrate of the artichoke consists chiefly of sugar, there is no starch, and consequently there is no mealiness produced on boiling as is the case with the potato.

Turnip.—The turnip as commonly used is the result of cultivation. The Swedish turnip sprang from a wild plant, the *Brassica campestris*, belonging to the natural order *Cruciferæ*. The wild plant has a spindle-shaped bitter root, little resembling the cultivated article. As the table shows it possesses little value as a food. It contains no starch, but a carbohydrate in the form of pectose, and very little albuminous material. A pungent essential oil is one of its ingredients. The **prairie turnip** of North America, which is much used as potatoes are elsewhere, has no relationship to the ordinary turnip. It is a tuber and belongs to the leguminous order of plants.

Carrots are also a product of cultivation, derived from the wild carrot (*Daucus Carota*), of the order *Umbelliferæ*, to which also celery, parsnip, and the poisonous hemlock belong. It grows abundantly in Britain, and is said to have been introduced during the Elizabethan period by the Flemish refugees who settled at Sandwich. The wild plant has a pungent odour and acrid disagreeable taste. Of the carbohydrate 4·5 per cent is sugar, the remainder is gum and pectose. The sugar can be removed in the shape of syrup, and submitted to fermentation to yield spirit. It is said that a substitute for coffee can be made from them, if they are first cut into pieces and roasted.

Parsnip (*Pastinaca sativa*). The parsnip belongs to the same order as the carrot, *Umbelliferæ*. It is a cultivated variety of a wild plant native to Britain. It contains about an equal percentage of sugar and starch, 3 of sugar, 3·5 of starch, the remaining carbohydrate being pectose. Spirit can also be prepared from it, as from carrot.

Beet-root.—There are several varieties of the beet. The common red beet is *Beta vulgaris*. There is the sea-beet (*B. maritima*), supposed to be the origin of the common form and of the sugar-beet, a white variety of *B. vulgaris*, and the field-beet or mangold-wurzel (*B. altissima*). They belong to the order of the goosefoots (*Chenopodiaceæ*). They are native to the south of Europe, and were introduced into Britain in 1656. Of the 13·4 per cent of carbohydrate 10 is sugar; and on this account the beet, especially the white variety, is grown extensively for the production of sugar and the distillation of alcohol. Thus the order of richness in sugar of carrots, parsnips, and beet-root is—

Parsnips, ...	3·0 per cent.
Carrot, ...	4·5 ,,
Beet-root, ...	10·0 ,,

Radish (*Raphanus sativus*) belongs to the natural order *Cruciferæ*, the same order which includes mustard and turnip. It is native to China, and has been cultivated in England since 1548. The roots are spindle-shaped or round like small turnips, and the exterior may be white, red, black, or violet, but the interior is always white. In composition it resembles the turnip, though it is less digestible, specially as it is usually eaten raw. The young leaves are used as a salad and the green pods as a pickle. The horse-radish (*Cochlearia Armoracia*), with a tap-shaped root, is employed in medicine because of the pungent acrid volatile oil, identical with oil of mustard, which it contains.

Salsify or **Purple Goat's-beard** (*Tragopogon porrifolius*) belongs to the order *Compositæ*. There are several varieties, the greater goat's-beard and the yellow, besides the purple. The name is due to the feathery appearance of the seeds. Salsify has a long tapering root, fleshy and tender, and yielding a milky juice. It is usually boiled or stewed, and has a sweetish taste like parsnip. It is also beat up with potatoes, after being boiled, and fried in small cakes, and from its taste when so cooked it is called the "oyster plant."

In Chili, Peru, and Bolivia there are several plants grown for their tubers, which are used for food, such as *Oxalis crenata*, *Oxalis tuberosa*, and which become mealy like potatoes on boiling. And there are many others of a like character in different parts of the world which are largely used as potatoes or yams.

HERBACEOUS ARTICLES.

Under this head are included the shoots, stalks, leaves, fruit, and seed of various plants, and sometimes the whole plants. The composition of some of the chief of them is shown in the following table:—

Average percentage Composition of Cabbage, Sea-kale, Lettuce, &c.

	Cabbage.	Sea-kale.	Savoy.	Cauliflower.	Spinach.	Lettuce.	Celery.	Water-cress.	Onion.	Asparagus.	Parsley.	Rhubarb.
Water	89·97	93·3	87·09	90·39	90·26	94·33	93·3	93·2	91·0	93·32	85·55	95·1
Nitrogenous	1·89	2·4	3·31	2·53	3·15	1·41	1·2	1·7	1·5	1·98	3·66	0·9
Carbohydrate (starch, sugar, &c.)	4·87	2·8	6·02	5·01	3·34	2·19	3·8	2·9	4·8	2·74	7·44	2·4
Fat	0·20	—	0·71	0·38	0·54	0·31	—	0·2	0·2	0·28	0·22	—
Fibre	1·84	0·9	1·23	0·87	0·77	0·73	0·9	0·7	2·0	1·14	1·45	1·1
Saline	1·23	0·6	1·64	0·82	1·94	1·03	0·8	1·3	0·5	0·54	1·68	0·5

It is convenient to group these numerous vegetables together, though they belong to widely different orders of plants, because the nutritive value of all of them is alike comparatively low, and, in the main, their value as food-stuffs depends upon the variety and flavour they impart to a meal, and also largely upon the salts and acid which they convey to the body. On this last account they are very useful in the prevention of scurvy. They are also distinguished from food-stuffs already considered in possessing chlorophyll, the green colouring matter of plants. Many of them possess also peculiar essential oils, usually of a pungent character, which confer upon them a peculiar flavour and sharpness. They all possess a very large proportion of water; and though many contain a larger proportion of nitrogenous material than potatoes and other vegetables already considered, they show a falling-off in the carbohydrate element. Of this element the large proportion in most of them is sugar. Thus in cabbage 2·29 of the 4·87 per cent is sugar; in celery 2·2 of the 3·8 per cent is sugar; in cauliflower the sugar is 1·27 per cent; in savoy, 1·29; in parsley, 0·75.

Cabbage belongs to the natural order *Cruciferæ*. The wild plant from which it sprang, the sea-cabbage (*Brassica oleracea*), grows upon the cliffs of the southern and western coasts of the British Isles. The term **colewort** is used as a general one to apply to all the plants of the genus. The final "wort" is the Saxon wyrt, a root, German wurz; while "cole" is the same as the Scotch "kale" or "kail," German "kohl," Saxon "caul." The ordinary white cabbage, savoy, Brussels sprouts, broccoli, cauliflower, and the red cabbage used for pickling, are all varieties of the original sea-cabbage—a small unimportant plant in comparison with its descendants. The cauliflower is the flower or inflorescence of the plant, developed by cultivation; Brussels sprouts are the buds which appear in the axils of the leaves, the angle between the leaf and the stem of the plant. The cabbage tribe is, as a rule, difficult of digestion, and in the bowels

sulphuretted hydrogen is apt to be formed from the abundance of sulphur they contain, thus occasioning offensive flatulence. The German sauerkraut is made from sliced cabbage, sprinkled with salt, pressed in tubs or barrels, and allowed to ferment till it becomes sour.

Sea-kale (*Crambe maritima*) is a hardy seashore plant, now grown in gardens and brought to great perfection, in which state it is said to be delicate and easy of digestion. By keeping the light from it, as is done with celery, it is kept white and an acrid taste prevented from developing.

Spinach (*Spinacia oleracea*) belongs to the same order as the beet (*Goosefoot* or *Chenopodiaceæ*). It is a native of Western Asia, and was introduced to England in the sixteenth century. The mountain spinach, a native of Tartary cultivated in France, belongs to the same tribe. It is the leaves of the plant that are used after being boiled, and sometimes as a salad.

Lettuce (*Lactuca sativa*) belongs to the *Compositæ*. It is a hardy plant, one of the chief vegetables used as salad because of its crispness and the quantity of water it contains, which makes it cool and refreshing. Such vegetables should be kept in water till used, as they absorb the water, remaining juicy and crisp instead of becoming dry. **Lactucarium or lettuce-opium,** is a drug obtained from the juice expressed from the flowering herbs of the garden and wild lettuce, and thickened by gentle heat. It possesses some slightly soothing properties, and is very occasionally given to induce sleep.

The **Endive** (*Cichorium Endivia*) belongs to the same order as the lettuce. It is a native of Northern China. It is the blanched leaves that are used, but it has a bitter taste.

Celery (*Apium graveolens*) belongs to the *Umbelliferous* order, native to Britain, growing wild in sandy marshes, and called **smallage.** The taste and smell of the wild plant are coarse and rank. By cultivation, however, by a method introduced from India, it becomes tender and pleasant. It is supplied with abundance of water and earthed up just to the tops of the leaves. It is used as a flavouring agent for soups and also as a salad. It contains a minute quantity of an essential oil, to which its peculiar aromatic properties are due.

Water-cress is a cruciferous plant, of which there are many varieties. The water-cress is *Nasturtium officinale*, the common garden-cress is *Lepidium sativum*. The water-cress is native to Britain, and grows in rivulets or shallow streams or ditches. Its pungent flavour is due to an essential oil. The common cress is a native of the East. Belonging to the same order is **white mustard** (*Sinapis alba*), whose leaves are also used as a small salad.

Onion and **Asparagus** both belong to the Lily order. The former (*Allium Cepa*) is a native of the Levant. The same species includes the shalot, leek, garlic, and chive. All of these possess a very strong pungent taste and smell, due to a volatile oil, rich in sulphur, which they contain in minute quantity. This oil confers a marked stimulating and irritating property on the plants. **Asparagus** (*Asparagus officinalis*), called vulgarly sparrow-grass, is originally a wild sea-coast plant, but is now grown in gardens. The part used is the young shoot, which constant cultivation has made delicate and tender. From the shoots a crystalline substance, asparagin or althein, can be separated. It is also found in the potato, in belladonna, in liquorice and marsh-mallow roots. It is used in some forms of dropsy and gout.

Parsley is an umbelliferous plant, the common kind (*Petroselinum sativum*) is a native of Sardinia. An essential oil with the peculiar aroma of the plant can be separated from it.

Artichoke, to be distinguished from Jerusalem Artichoke, is of the order *Compositæ*. It is the green flower-head of the plant (*Cynara Scolymus*), native to Barbary and South Europe. Another plant of the same genus, the **cardoon** (*C. Carduncellus*) is used on the Continent. The parts used are the thick, fleshy stalk and leaf-ribs. They are blanched for use. It is a native of countries on the Mediterranean shore.

Many other plants, in whole or part, are used as salad, &c., such as borage, sorrel, rape, dandelion leaves, and many others.

Rhubarb, though usually called a fruit, that is, the portion that is used for tarts, is really the fleshy leaf-stems of the plant. It belongs to the same natural order as buckwheat, the *Polygonaceæ*. It comes from the river Volga, whence it was brought in 1573. The root of the Turkey rhubarb is used as medicine. *Rheum* is the name of the plant, the English rhubarb being *R. rhaponticum*, the medicinal kind being *R. officinale*. Formerly the leaves were boiled to yield a sauce used for meat. As a nutrient it is of little value, but its juice and mineral matter are valuable. The quantity of sugar it contains (2 per cent) enables a home-made wine to be manufactured from it.

FRUITS.

Average percentage Composition of Cucumber, Vegetable Marrow, and Tomato.

	Cucumber.	Vegetable Marrow.	Tomato.
Water	96·2	94·8	89·8
Nitrogenous	0·2	0·6	1·4
Carbohydrate (starch, sugar, &c.)	2·7	2·6	6·7
Fat	—	0·2	—
Fibre	0·5	1·3	1·3
Saline	0·4	0·5	0·8

These three fruits have been placed together because they are used rather as vegetables than as fruits in the ordinary sense of the word. They are, however, the fruits of their respective plants.

Cucumber belongs to the natural order *Cucurbitaceæ* (*Cucurbita*, Latin, a gourd), to which also belong the gourd, the pumpkin, the melon, and of medicinal plants the colocynth (bitter-apple or bitter-cucumber) and bryony. The common cucumber is the *Cucumis sativus;* it is native to the Levant, and was introduced into England in 1573. They flourish best in rich, open soil, need plenty of water, and are more juicy and digestible when grown quickly under glass. They are, however, in any form rather difficult of digestion, and are specially so when raw. The addition of vinegar, pepper, &c., aid digestion by stimulating the stomach. They are really of no nutritive value, consisting mainly of water, as the table shows; the only nutrient is 2 per cent of sugar. When young, cucumbers are pickled under the name of gherkins.

Vegetable Marrow is akin to the pumpkin and common gourd, belonging to the same order as they and cucumber. It is *Cucurbita ovifera.* The **Squash** is a variety of the same plant. It contains less water and more nutrient than cucumber. Of the 2·6 per cent of carbohydrate, 2 is sugar and ·6 starch. It is a wholesome adjunct to food.

Melon (*Cucumis Melo*) is a variety of the gourd. The water-melon (*Citrullus vulgaris*) is another variety.

Tomato (*Lycopersicum esculentum*, love-apple) belongs to the Nightshade order (*Solanaceæ*), as does the potato and tobacco. It is a native of South America. In Britain they grow best in hothouses. They are used in all sorts of ways, cooked in sauces, or raw, with the addition of pepper and salt, or in their natural fully ripe state without any adjunct. They have a very agreeable flavour, and are readily digestible. They contain ·7 per cent of a free acid—malic acid—the same as exists in the apple, pear, and plum.

Egg-apple (Fig. 202) (a variety of *Solanum esculentum*) is used for sauces, or boiled, and otherwise used as the tomato. It is the fruit of the plant to which the term egg-apple, aubergine, or brinjal is applied. "It is of an elongated form and purple colour. It is somewhat largely eaten on the Continent, and to some extent also in England; but it is dry and spongy, and devoid of the agreeable qualities belonging to the tomato. In America it is a favourite vegetable, and is there usually sliced and fried."

Fig. 202.—Egg-apple.

Average percentage Composition of Apples, Pears, Plums, Grapes, &c.

	Apples.	Pears.	Plums.	Damsons.	Peach.	Cherries.	Grapes.	Gooseberries.	Currants.	Strawberries.	Oranges.
Water	83·0	84·0	84·8	81·2	85·0	80·3	80·0	86·0	84·8	87·7	89·0
Nitrogenous	0·4	0·3	0·4	0·8	0·5	0·6	0·7	0·4	0·5	1·1	0·7
Sugar	6·8	7·0	3·6	6·2	1·8	10·2	13·0	7·0	6·4	6·3	4·6
Other non-nitrogenous substances	5·2	4·6	4·7	4·9	8·0	1·2	3·1	1·9	0·9	0·5	1·0
Free acid	1·0[1]	0·1[1]	1·5[1]	0·8[1]	0·7[1]	0·9[1]	0·8[2]	1·5[3]	2·1[1]	0·9[4]	2·4[3]
Fibre	3·2	3·7	4·4	5·4	3·4	6·1	2·0	2·7	4·6	2·7	1·8
Saline	0·4	0·3	0·6	0·7	0·6	0·7	0·4	0·5	0·7	0·8	0·5

[1] Malic acid. [2] Tartaric acid. [3] Citric acid. [4] A mixture of citric and malic acids.

The fruits in the above list have all very much the same characters, so far as chemical composition is concerned. In all of them there is a very low proportion of nitrogenous constituent, but a considerable quantity of carbohydrates, especially sugar, and other non-nitro-

genous substances such as gum and pectin, the jelly-like material obtainable from fruits. The quantity of sugar varies with the degree of ripeness. In the unripe condition starch rather than sugar is present, but by process of ripening the starch becomes transformed. At the same time much of the acid and astringent constituents of the unripe fruit disappears. It is during this process that the special flavour is developed, the transformation being the result of the absorption of oxygen, which is characteristic of ripening fruit. When the fruit is overripe, fermentive changes have set in, and changes of decomposition, by which the fleshy part of the fruit is broken down, and the seed which it shelters liberated. Besides, for the sugar, &c., which they contain, fruits are valuable for their free acid, which varies in different fruits, being malic, citric, tartaric, or a mixture of some of them (see foot-notes), and also for their saline ingredients. These vegetable acids and salts are specially serviceable when salted or preserved meats are largely used in the diet, as they supply ingredients that without them would be wanting, and whose absence would occasion a very unhealthy condition, scurvy being apt to arise. They are useful also in correcting the tendency to the accumulation of excessive quantity of acid in the body, especially uric acid, of which gout, and probably to some extent also rheumatism are manifestations. Taken freely, these substances diminish the acidity of the urine, and, if taken in larger quantities, render it alkaline. A diet rich in animal food is apt to occasion unsatisfactory states of general health, because of the excessive storing of acid in the system. There is little doubt that the advantage experienced by many from a more free use of fruits than is customary is due to their power to diminish this acidity. Some forms of headache, especially the sick or nervous headache, megrim, are supposed to be partly caused by such excessive accumulation of acid in the system. It would be worth while for those, subject to complaints of this kind, to try the effect of free use of such fruits as oranges, lemons, and tomatoes.

Apples, Pears, Quinces, and **Medlars** all belong to the sub-order *Pomeæ* of the natural order of the rose (*Rosaceæ*). The apple-tree is called *Pyrus Malus;* the pear is *Pyrus communis.* The varieties of cultivated apples have sprung from the wild, or crab-apple of the hedges, a native of Great Britain. It grows in all temperate climates. Normandy pippins, or "biffins," are apples dried and flattened. **Cider** is the fermented juice of apples, **verjuice** of the crab-apple, and **perry** of the pear. Apples seem not to be so difficult of digestion, when raw, as is generally supposed, if they are well chewed. Stewed or roasted, they are still more easy of digestion. They are useful in persons troubled with habitual costiveness of bowels.

Fig. 203.—Sour-sop or Anona (*Anona muricata*).

The term apple is applied to other fruits of quite different kinds. Thus the **custard-apple** is the fruit of the *Anona reticulata*, of the same tribe as the sour-sop of the West and East Indies. (See fig. 203.) The **egg-apple** belongs to the same order as the tomato, and is used as a vegetable (see p. 574).

The **Quince** is the fruit of *Pyrus Cydonia*, or *Cydonia vulgaris.* It is supposed to be a native of Western Asia. The fruit is golden yellow. In temperate climates, because of its want of ripening, it is used cooked in sugar, or made into marmalade. The Bengal Quince, *Ægle Marmelos,* golden apple, or bael fruit belongs to the orange order.

Fig. 204.—Quince (*Cydonia vulgaris*).

The **Medlar** is the fruit of the tree *Mespilus germanica,* which grows wild in several parts of Central Europe and in Britain. The pulp is very tough, but becomes soft when decay has set in, in which condition the flavour is deemed best.

Fig. 205.—Peach (*Amygdalus persica*).

Plums, Damsons, Apricots, Peaches, and **Cherries** all belong to the *drupaceous* or stoned-fruit class of the Rose order. The common plum

is *Prunus domestica*, which is a native of Asia Minor. There are various species belonging to different temperate climates. The damson is a plum originally derived from Damascus, and the green-gage is another variety. **Apricots** are the fruit of *Prunus armeniaca*. **Cherries** are the fruit of *P. Cerasus*. Their richness in sugar is a notable feature. **Kirschwasser** is a liqueur obtained from them. **Maraschino** is another liqueur prepared from a more delicately-flavoured kind. Prunes, or French plums, are dried plums, the finest being called by the latter name. The **peach** belongs to the genus *Amygdalus*, the *A. persica*, the almond group of *Rosaceæ*. The composition given in the table does not include the stones. It will be seen that their nutritive value is insignificant. **Nectarines** are a variety of the same tree.

Grapes. The grape is the fruit of *Vitis vinifera*, of the natural order *Vitaceæ*, native to the East, about the region south of the Caspian. There are a great many varieties. Raisins are the dried fruit, and currants are small varieties. **Sultanas** are raisins without stones; **muscatels** are the finest sort, dried in the sun on the branch, after the stalk is partially cut through. The large percentage of sugar contained in grapes gives them a pre-eminence as regards nutritive quality above every other fruit of the berry kind. Raisins contain 45 per cent less water than grapes, a total of only 32 per cent, and they contain no less than 55 per cent of sugar, so that they are highly nourishing, though the nitrogenous element amounts to only 2·4 per cent. The value of associating almonds and raisins is seen from the fact that the former contains 24 per cent of nitrogenous material and nearly 54 per cent of fat, they are, that is to say, very rich in exactly the ingredients in which raisins are deficient. The acid of the grape is chiefly tartaric, and it is usually combined with potash to form tartrate of potash.

"I think we may assert," says Dr. Cullen, "that grapes, which contain a large quantity of sugar, are, if taken without their husks, the safest and most nutritive of summer fruits." "In the inflammatory form of dyspepsia, and in pulmonary affections, ripe grapes are eaten, in considerable quantities, in Switzerland and other parts of the Continent, occasionally with considerable benefit, and forming what is called the 'cure de Raisins'" (Pereira). They act both upon the bowels and kidneys, gently stimulating the action of both, specially if taken in the morning on an empty stomach.

Strawberries are natives of temperate climates, and are found in Europe, America, and Asia. They belong to the Rose order, to the genus *Fragaria*, the common strawberry being *F. vesca*. The English strawberry has reached its present condition as the result of cultivation. They are not rich in nutritive material, but if eaten alone, or only with sugar, they are digested with comparative ease.

Currants and **Gooseberries** belong to the tribe *Grossulaceæ*, of the natural order *Saxifragaceæ*. The currant plant is *Ribes*, the red currant being *R. rubrum*, and the black *R. nigrum*, while the gooseberry is *R. grossularia*. The latter is native to many parts of Europe and Northern Asia. The currants are also natives of Europe and Asia and some parts of North America. Both currants and gooseberries are alike in alimentary properties, which are of little consequence. These currants are to be distinguished from the dried currants, which are small black dried grapes.

Raspberries and **Blackberries** (brambles) belong to the sub-order *Roseæ* of the natural order *Rosaceæ*. The former (*Rubus idæus*) is a native of Britain; the latter (*Rubus fruticosus*) is also indigenous in Britain and Europe generally. It is a hedge bramble. The **Dewberry**, or grey bramble (*R. cæsius*), does not grow in hedges but on the ground.

Bilberries or **blaeberries** (Fig. 206) (*Vaccinium myrtillus*), **bog whortleberry** (*V. uliginosum*), **red whortleberry** or **cowberry** (*V. vitis idæa*), **marsh whortleberry** or **cranberry** (*V. oxycoccus*), all belong to the natural

Fig. 206.—Bilberry.

Fig. 207.—Barberry (*Berberis vulgaris*).

order *Vacciniaceæ*. They are found in Britain, Europe, and America. They are all very much alike in chemical composition.

Barberry (Fig. 207) (*Berberis vulgaris*) belongs to the order *Berberidaceæ*. It is very acid and astringent, found in Europe, Asia, and America, in hedges. Pepperidge or peprage bush is an old name in England for the plant. The berries are oval in form, and generally

bright red. A mordant for dyers is made from the bark.

Elder-berries are the fruit of *Sambucus nigra,* small trees or shrubs of the natural order *Caprifoliaceæ.* The honeysuckle and viburnum belong to the same order. It is native to Europe and the north of Asia and Africa. The branches of the tree contain an unusually large amount of pith, which is easily removed, so that tubes are readily formed. Hence the name bore-tree, and in Scotland bour-tree. Elderberry wine is a highly-flavoured wine made from the berries, which are black in colour and faintly acid to taste. Elder-rob is the juice obtained by pressing the berries.

Mulberries (Fig. 208) are the fruit of the *Morus nigra,* of the order *Urticaceæ,* or *Moraceæ,* the same order to which fig belongs. It is a native of Persia, but is extensively grown in Europe. The fruit is purplish-black, more than usually acid, and with a fine flavour. It is cooling and slightly laxative.

Fig. 208.—Black Mulberry (*Morus nigra*).

Oranges are the fruit of the *Citrus,* belonging to the natural order *Aurantiaceæ.* The sweet orange is *C. Aurantium* (Fig. 209). It is supposed to be native to India and China, but has long been grown in Egypt, Italy, Spain, and other parts of Southern Europe. It is in perfection only when gathered ripe from the tree. The imported oranges are all pulled while yet unripe. The nutrients it contains are too small in quantity to make the fruit valuable from that point of view, but the acid it contains, and the salts, and the essential oil of the rind, confer upon the fruit a very high value, and make them exceedingly valuable and wholesome food adjuncts. When quite ripe it may be partaken of in almost any state of health, the pulp being, of course, rejected after the juice has been sucked out. The acid is citric acid, and it is united in the fruit with potash, chiefly as citrate of potash. There are several varieties of the orange. The bitter or Seville orange is *C. vulgaris.* The rind is rich in flavouring oil, and is largely used for flavouring, and for the extraction of tincture, to be employed as an aromatic tonic. The flavour of the liqueur curaçoa is due to the bitter orange. From the flower of this variety, also, the finest orange-flower water is distilled. From orange-flowers another oil is obtained—the oil of neroli. The mandarin orange is a variety of the sweet orange. So also is the Malta orange with its blood-red flesh. The **Citron** (*C. Medica*) is a different species. The **Lime** (*C. acida*) is native to the East, and is grown in the West Indies and south of Europe. It is smaller than the lemon. Its juice is very acid, and is extensively used as a preventive of scurvy. The **Sweet Lime** (*C. Limetta*) is a variety.

Fig. 209.—Orange (*Citrus Aurantium*). *a*, Ovary. *b*, Style. *c*, Stamens. *d*, Petal. *e*, Section of fruit.

The **Lemon** (*C. Limonum*) is a native of the north of India, but is grown also in Southern Europe. The juice is more acid than that of orange, and is very extensively used for a refreshing beverage, the essential oil from the rind being also a popular flavouring agent.

The **Shaddock** (*C. decumana*) and the **Pomelo** or **Pompelo** (*C. Pompelmoos*) very much resemble one another and the orange. The latter is the fruit sometimes called "the forbidden fruit."

The **Cumquat** (*C. japonica*) is another species of *Citrus.* All these varieties have the same general characteristics of juicy acid fruits and aromatic oils in the rind.

The **Pomegranate** (Fig. 210), fruit of the *Punica granatum,* is not unlike the orange. The pulp is reddish, slightly acid. The rind is very astringent, and is used sometimes on this account. The root has the same action, and is used in medicine; the dried root is used for yielding an astringent decoction. The *Punica granatum,* however, does not belong to the same order as the orange, but to the order *Myrtaceæ,* to which cloves, all-spice, cajeput, and the blue-gum tree belong. **Guava** (*Psidium pyriferum*) also belongs to the same order as pomegranate. It yields the well-known West Indian preserve, guava-jelly. Guava preserves are also

Fig. 210.—Pomegranate (*Punica granatum*).

largely made at the Cape Colony. It is a roundish fruit, larger than a hen's egg, with smooth yellow rind, and firm flesh-coloured pulp, filled with hard seeds, of sweetish aromatic taste. There are several varieties of it—red guava and China guava, which are more acidulous to taste than the common or white variety.

Average Percentage Composition of Figs, Dates, and Bananas and Bread-fruit.

	Dried Turkey Figs.	Dates (stoned).	Bananas (peeled).	Bread-fruit.
Water	17·5	20·8	73·9	63
Nitrogenous	6·1	6·6	4·8	3
Carbohydrate (starch, sugar, &c.)	65·9	65·3	19·7	14
Fat	0·9	0·2	0·6	
Fibre	7·3	5·5	0·2	20
Saline	2·3	1·6	0·8	

These fruits occupy a very different position from those of the preceding table, dependent upon their great alimentary value. Rich in starch or sugar, and with a proportion of albumin and a very small percentage of fat they are, each of them, capable without further addition, except that of water, of sustaining life for prolonged periods. Though generally regarded simply as pleasant fruits, in the ordinary meaning of that word, they form in some parts of the East the main food of the people for certain seasons.

Figs are the fruit of the *Ficus carica* (Fig. 211), belonging to the natural order *Moracœe*, to which the mulberry and banyan belong, and to which the india-rubber tree (*F. elastica*) of commerce belongs. It is grown in warm climates, native to the East and naturalized in Southern Europe, attaining its perfection along

Fig. 211.—Fig (*Ficus carica*).

Fig. 212.—Sycamore (*Ficus sycomorus*).

the Mediterranean shores, and in Turkey. The fig as eaten is really a hollow fleshy receptacle for the fruits, which are concealed within it. In the ripe state the so-called seeds are the actual fruits, the ripe carpels or seed-vessels of the flowers. Of the fig there are numerous varieties, differing in size, colour, &c. The **sycamore** (*Ficus sycomorus*, Fig. 212) is a species of fig. Its fruit is also eaten and is sweet and delicate; it is smaller than the ordinary fig.

The table shows the composition of the finest dried figs. The carbohydrate is mainly sugar, to the extent of $57\frac{1}{2}$ of the 65·9 per cent. By referring to p. 562 it will be seen that they contain almost as much nitrogenous material as fine white bread, and over 13 per cent more carbohydrate and more fat. One may, therefore, say they contain more nutriment than bread, but the so-called seeds are liable to cause irritation of the bowel if they are eaten in large quantity. One of the finest figs steeped over night in a quantity of water such that it can absorb, and eaten in the morning on rising, is a gentle aid to relaxation of the bowels.

The **Banyan** (*Ficus indica*) belongs to the same order as the fig, and produces edible fruit

Fig. 213.—Banyan Tree.

of the size of a cherry. It is a tree remarkable for size, owing to its manner of growth. The branches send down shoots which take root and grow into trunks, and thus the tree spreads till it covers a large area. A famous tree on the banks of the Ner budda has 350 such stems, each of the size of an ordinary trunk, and 3000 smaller ones. It can shelter beneath it 7000 men (Fig. 213).

Fig. 214.—Prickly-pear.

Indian-fig or **Prickly-pear** (Fig. 214) (*Opuntia vulgaris*) does not belong to the fig or pear order, but to the Cactus order (*Cactaceæ*). It is a native of America, and is grown in Southern Europe and North Africa. The fruit resembles a fig of a deep rose colour, larger than a hen's egg, with juicy and sweetish acid pulp.

Dates are the fruit of the date-palm (Fig. 215)—the palm-tree of Scripture (*Phœnix dacty-*

lifera). It is a native of the north of Africa and parts of Asia, and has been brought to Southern Europe. Its stem passes straight up without branch or interruption to a height of 50 or 60 feet, and then throws out a crown of feather-shaped leaves. The fruit is in bunches of 180 to 200 dates, each bunch weighing 20 to 25 pounds. The fruit is eaten in the fresh ripe state, or dried, and also pounded or pressed into a kind of cake, for the use of travellers through the desert, and the inhabitants of Northern Africa. The table shows the composition of the date as imported and after being stoned. In this condition it is in chemical composition much like the fig. The date-palm "is invaluable amid parched sands and arid deserts. Wherever a spring of water appears amid the sandy deserts of Africa, this graceful palm yields at once both its grateful shelter and its nourishing fruit. Where all other crops fail from drought the date-tree still flourishes. In Egypt and Arabia it forms a large portion of the general food, and among the oases of Fezzan 'nineteen-twentieths of the population live upon it for nine months of the year'" (Johnston).

Fig. 215.—Date-palm (*Phœnix dactylifera*).

Banana is the fruit of a favourite tropical tree (*Musa sapientum*, Fig. 216) of the natural order *Musaceæ*. The leaves are 6 feet long by 1 broad, and are used for thatching, basket-making, &c., while the quantity of fibrous tissue in the stalks makes them useful for the production of flax. Manilla hemp is yielded by a tree of the same order (*M. textilis*). The fruit grows in bunches of from 100 to 200, weighing 40 to 80 pounds. Its main constituent is, in the unripe state, starch, which in process of ripening becomes converted into sugar. Of very luscious taste it is a wholesome and nutritious food. The tree yields, for the same extent of ground covered, more food than any other vegetable. According to Humboldt 1000 square feet of ground will yield of potatoes 462 pounds, of wheat 38 pounds, and of bananas 4000 pounds, and in a shorter period of time. "About $6\frac{1}{2}$ pounds of the fruit, or 2 pounds of the dry meal, with $\frac{1}{4}$ pound of salt meat or fish, form, in tropical America, the daily allowance for a labourer, whether slave or free." The unripe fruit keeps better than the ripe, because of the carbohydrate being yet starch, and when dried in this state forms a kind of bread. Meal is prepared by pounding and sifting the dried fruit.

Fig. 216.—Banana (*Musa sapientum*).

The **Plantain** (Fig. 217, *Musa paradisiaca*), a variety of the same plant as the banana, yields a fruit almost identical with it, and equally useful. In British Guiana the meal, obtained by drying and pounding the fruit, is largely used for children and invalids.

Fig. 217.—Plantain-tree (*Musa paradisiaca*).

Fig. 218.—Bread-fruit (*Artocarpus incisa*).

Bread-fruit (Fig. 218) is obtained from a tree (*Artocarpus incisa*) found in the islands of the Pacific, specially in the Friendly and Marquesas Islands. The fruit is round and about the size of a child's head, being formed of the female flowers united into a fleshy mass. Several crops appear in succession, the tree flowering for eight or nine months continuously. Like the banana its chief ingredient is carbohydrate, which becomes sugar when the fruit is fully ripe, but is in the form of starch when unripe. Raw, the fruit is insipid in taste, and it is, therefore, usually plucked before being ripe; the rind is removed and the white pith is wrapped in leaves and baked on hot stones. "In this state it tastes like white wheaten

bread, sometimes rather sweeter." During the months when the tree is not bearing, the unripe fruit is used in a preserved state. The preservation is effected in paved pits covered with leaves and stones, where the fruit becomes sourish and forms a kind of paste, of which a piece is baked on stones as required. In this form it is said to taste like black Westphalian bread when not thoroughly baked. These trees, it is said, will yield fruit sufficient to sustain one man for eight months. "Whoever has planted ten bread-fruit trees has fulfilled his duty to his own and succeeding generations as completely and amply as an inhabitant of our rude clime, who, throughout his whole life, has ploughed during the rigour of winter, reaped in the heat of summer, and not only provided his present household with bread, but painfully saved some money for his children" (Captain Cook).

A variety of the bread-bruit is **Jack-fruit**, yielded by the *Artocarpus integrifolia.* The tree is grown in Southern India and in Asia, and the fruit is much used in Ceylon. It is coarser than the bread-fruit.

NUTS.

Average percentage Composition of Nuts.

	Almonds.	Filberts.	Walnuts.	Cocoa-nuts.	Pea-nuts or ground-nuts.	Chestnuts.
Water	5·4	4·1	4·7	46·6	7·5	51·5
Nitrogenous	24·2	15·6	16·4	5·5	24·5	5·5
Starch, gum, &c.	7·2	9·0	7·9	8·1	11·7	38·3
Fat	53·7	66·1	62·9	35·9	50·0	1·4
Fibre	6·5	3·3	6·1	2·9	4·5	1·6
Saline	3·0	1·9	2·0	1·0	1·8	1·7

The prevailing characteristic of nuts is well shown in the above table. They are all rich in oil, exceptionally rich indeed, with the exception of the chestnut. The proportion of oil, scarcely below 50 per cent in any, gives them a very high alimentary value. At the same time they are also rich in albuminoid material, on an average as rich in that ingredient as flesh meat. They contain comparatively little starch. In fact the starch of the cereals is in the nuts replaced by oil. Although thus a very nourishing food they are rather difficult of digestion, unless when ground and mixed with some lighter kind of food, which will keep the nut in a finely-divided state. The fat is apt under exposure to become somewhat rancid. The chestnut is quite an exception to these general rules. It is a farinaceous seed, the starch taking the place of oil in quantity, and it is much less rich in nitrogenous material, resembling, therefore, the cereals.

Almond is the seed of the *Amygdalus communis* (Fig. 219), belonging to the natural order *Rosaceæ.* It belongs to the East, and is extensively cultivated in the south of Europe. The bitter almond (*A. amara*) is a variety of the former. The sweet almonds imported from Malaga, and called Jordan almonds, are the finest. By pressure the oil may be separated from the nut, the ordinary almond-oil of commerce, consisting chiefly of olein, which is bland, harmless, and odourless. From bitter almonds, by distillation, a volatile oil may be separated, which is of a different character. As sold in the shops it contains prussic acid, and is highly poisonous. This poisonous property is due to the presence of hydrocyanic or prussic acid, which, however, does not exist in the seed as such, but is produced as a result of a fermentation set up when the seed is moistened. This fermentation is due to the action of two substances contained in the seed, emulsin, an albuminous substance, and amygdalin, a crystalline nitrogenous substance. The result of the interaction of these two substances is the production of the volatile oil (essential oil of bitter almonds), prussic acid, and other substances. The prussic acid may be driven off from the oil by heat, and then the oil is harmless. But this is not usually done, and the oil retains its poisonous character. This fermentive change may occur in the mouth on chewing the bitter almond, and risk consequently attends their being eaten. Pereira says "the smaller animals, as dogs, pigeons, &c., are readily destroyed by them. One drachm (60 grains) has killed a pigeon, and twenty seeds have destroyed a dog. . . . . Macaroons

Fig. 219.—Almond (*Amygdalus communis*).

and ratafia cakes, as well as noyau, which owe their peculiar flavour to these seeds, likewise prove injurious when taken in large quantities." The essence of bitter almonds, sold for flavouring purposes, is the essential oil diluted with spirit. It should not be freely employed.

Sweet almonds are apt to occasion very considerable digestive disturbance, if eaten without the skin being removed, that is unblanched. Almonds thus eaten have been known to produce sickness, swelling of the face, and nettle-rash. The favourite sweetmeat marzipan is a sweetened almond paste.

Filbert Nuts, Hazel-nuts, and **Cob-nuts** are all produced from varieties of the same plant, *Corylus*, natural order *Corylaceæ*, to which the oak, beech, and sweet chestnut belong. **Hazel-nuts** are derived from *C. avellana*, which grows wild in Great Britain; the best come from Spain, and are called Barcelona nuts. The **filbert** (*Corylus tubulosa*) is a carefully-cultivated variety, and to it the remarks made at the beginning of these paragraphs fully apply.

Walnuts are the seeds of a tree, *Juglans regia* (Fig. 220), of the order *Juglandaceæ*. It is a tall spreading tree, a native of Persia, and was introduced into Greece and Italy some centuries before the Christian era. A sweet oil, used for food and, under the name of nut-oil, as a drying oil for painting, may be expressed from them. Unripe, they are used for pickling and making ketchup. The **butter-nut** from *Juglans cinerea*, and the black walnut are varieties much cultivated in America. The hickory tree (*Carya alba*) yields a nut, the **hickory-nut**, and belongs to the same natural order. A variety of it, *Carya olivæformis*, yields the **pecan-nut**. These are all North American trees.

Fig. 220.—Walnut-tree (*Juglans regia*).

Cocoa-nut is the fruit of a palm, Fig. 221 (*Cocos nucifera*), belonging to the natural order *Palmaceæ*. The name is said to be derived from *coco*, meaning a distorted mask, the name given to the nut by the Portuguese in India, because of the markings at the base of the nut suggesting a monkey face. The tree is grown extensively in the tropics. The fruit is in bunches of 12 to 20, and a single tree will bear from 80 to 100 nuts. Every part of the tree is useful. A thick fibrous husk surrounds the shell, of which matting is made, as well as a yarn called **coir**, of which cordage may be made; the shell itself is used for bottles and drinking-cups, and if burnt yields valuable charcoal. From the flowering branch is obtained a sweet juice, which, when allowed to ferment, is called **toddy** or **palm-wine**, and from this the spirit called **arrack** is distilled. The table shows the richness of the nut in oil, which may be separated out by pressure. The edible portion is somewhat fibrous and indigestible. The nut, however, is the chief food of the inhabitants of Ceylon, the South Sea Islands, and other tropical regions. The milk of the cocoa-nut is pleasant and cooling, and has the following composition:—

Fig. 221.—Cocoa-nut Palm (*Cocos nucifera*).

Water	91·5
Nitrogenous	·46
Fat	·07
Sugar, &c.	6·78
Saline	1·19

The Ground-nut or **Pea-nut** (Fig. 222) is the fruit of a leguminous plant, the *Arachis hypogæa*, common to the warm parts of America. It is also cultivated along the West Coast of Africa. It flowers not unlike the pea. The seeds are in pods, borne on long stalks, which, after flowering is past, curl towards the ground, so that the pods become buried in the earth, where they come to maturity. They contain 50 per cent of oil, and when this has been removed by pressure, the cake that is left, rich in albuminous material and starch, is used for feeding cattle.

Fig. 222.—Ground-nut (*Arachis hypogæa*).

Pistachio-nuts, the fruit of a small tree, the *Pistacia vera* (Fig. 223), is native to Western

Asia, but cultivated along the Mediterranean coasts. To the same order belong the sumach, mango, and cashew. Mastic is the product of one of the pistacias (*P. lentiscus*). The fruit is like a small almond, and has a similar taste. The kernel contains chlorophyll, which gives it

Fig. 223.—Pistacia vera.

Fig. 224.—Anacardium occidentale. 1 1 1, Cashew-nuts.

a green colour. It is sometimes called the green almond. They are used for confectionery and dessert. Their composition is almost identical with that of the ground-nut (see table).

Cashew-nuts or **Acajou-nuts** (Fig. 224) are the fruit of the *Anacardium occidentale*, of the same order as the pistacia. It is a native of the West Indies. The nut is kidney-shaped, and about an inch long. The shell is very hard, and between its outer and inner layer there is a black acrid juice, which is driven off in very acrid fumes when the shell is roasted. The kernel contains a pleasant, wholesome oil, and is a common article of food in the tropics. The stalk of the fruit is large and fleshy, and may be eaten.

Brazil-nuts are the seeds of the juvia tree, *Bertholletia excelsa* (Fig. 225), belonging to the order *Lecythidaceæ*, which grow in abundance in Guiana, Venezuela, and in Brazil. The fruit consists of an outer hard shell, about ½ inch thick and 6 inches in diameter. Within it there are four compartments, each containing six or eight triangular nuts very closely packed. The kernel is rich in oil.

Fig. 225.—Fruit of *Bertholletia excelsa*.

Chilian Pine or **Puzzle-monkey** is a pine whose seeds are much used for food. The tree, *Araucaria imbricata*, is one of the *Coniferæ*, found in South America, Australia, and Pacific Islands. It is a favourite lawn tree in Britain. In Chili and Patagonia its seeds are used for food, and it is said "the fruit of one large tree will maintain eighteen persons for a year."

Dika Bread is made from the fruit of the *Irvingia Barteri* or *wild mango*, though it is not related to the Indian mango. It belongs to the order *Simarubaceæ*, to which quassia belongs. The tree grows on the West Coast of Africa. The fruit "is about the size of a swan's egg. It contains a large white almond-shaped kernel. The bruised kernels, warmed and pressed, form the so-called dika bread, which is largely consumed by the natives of the Gaboon, who use it when scraped or grated in stews" (Church). It consists to the extent nearly of three-fourths of fat, as the following note of its composition shows:—

Water	5·0
Nitrogenous	9·5
Starch	7·2
Fat	73·0
Fibre	3·0
Saline	2·3 (Church).

Chestnut.—The Spanish or sweet chestnut is the produce of a stately tree, the *Castanea vesca*, which is a native of Western Asia, and is largely cultivated in Southern Europe and in North America. It belongs to the natural order *Corylaceæ*, also called *Cupuliferæ*, to which also the oak, beech, and hazel belong. It is eaten raw or roasted; it is also ground into flour and made into bread, which is readily done, because of the large quantity of starch it contains and the minute quantity of fat. It is an important article of food in Southern Europe, of agreeable flavour, but somewhat difficult of digestion.

Fig. 226.—Chestnut (*Castanea vesca*).

FUNGI.

Average percentage Composition of Mushrooms, &c.

	Mushroom.	Morel.	Truffles. White.	Truffles. Black.
Water	90·0	90·0	72·4	72·0
Nitrogenous	5·0	4·4	9·9	8·8
Carbohydrates	3·8	3·7	15·2	16·6
Fat	0·7	0·6	0·4	0·6
Saline	0·5	1·3	2·1	2·0

Fungi are plants of a simple type of organization. They contain no chlorophyll, that is the green colouring matter of plants. They possess a considerable quantity of nitrogenous material, and are, therefore, of considerable alimentary value, but they are used mainly as flavouring and seasoning agents and for the production of sauces.

Mushroom.—There are many varieties of mushroom, some of them suitable for eating, many of them poisonous. It is said, also, that under circumstances of situation a mushroom, usually employed for food, may become hurtful. The species commonly used is the *Agaricus campestris*, or field mushroom. It is found growing in the open field in August and the two following months. It may be cultivated in gardens all the year round. They are eaten raw, boiled, baked, stewed or pickled, and when salted and pressed they yield ketchup. The mushroom consists of a net-work of thread-like material, the mycelium, growing underground. From this the stalk springs, bearing the head or cap or pileus of the mushroom. This is often of a sort of umbrella shape, and upon its under surface is a series of gills or bars, which bear the spores or seed of the fungus.

It is difficult to distinguish between good and poisonous mushrooms. As a rule, those suitable for food are white or brownish; the gaudily coloured are poisonous. The suitable kinds are found growing in the open fields, not in damp, shady places. Bentley gives the characters as follows:—

Mushrooms suitable for eating:

1. Grow solitarily in dry airy places.
2. Are generally white or brownish.
3. Have a compact brittle flesh.
4. When cut do not change colour by the action of the air.
5. Have a watery juice.
6. Their odour is agreeable.
7. Their taste is neither bitter, acrid, salt, nor astringent.

Poisonous mushrooms:

1. Grow in clusters in woods, and damp, dark places.
2. Are usually of a bright colour.
3. Have a tough, soft, or watery flesh.
4. Acquire a blue, green, or brown tint when cut and exposed to the air.
5. The juice is often milky.
6. The odour is commonly powerful and disagreeable.
7. Their taste is bitter, acrid, salt, or astringent.

Dr. Christison places reliance on the astringent styptic taste and disagreeable pungent odour as indicating certainly a poisonous fungus, though some poisonous kinds are devoid of any unpleasant smell.

The symptoms of poisoning from mushrooms are those of marked irritation of stomach and bowels, along with symptoms of brain disturbance. Thus there is colicky pain in stomach and bowels, sickness and purging, faintness and giddiness, dimness of sight, drowsiness, prostration and stupor. Sometimes the symptoms refer mainly to the stomach and bowels, and in other cases the symptoms are more those of a narcotic poison. They may arise very soon after the meal or not for some hours. If vomiting takes place soon, recovery is almost certain. To induce vomiting should be the first effort of treatment, a tea-spoonful of mustard in a tumblerful of hot water being a suitable means, tickling the throat with a feather, passing the finger down the throat, &c.

The poisonous active principle of one form of fungus—the fly fungus or fly amanita (*Amanita muscaria*, see Plate X.)—called muscarin, has been obtained from this fungus, which completely paralyses the heart of a frog, when it is touched with a drop of the solution. There is an antidote to this poison, namely belladonna (deadly nightshade) or its active principle atropina. Of tincture of belladonna 5–15 drops might be given every two or three hours while danger lasted, or, if the liquor atropiæ is to be had, a drop may be given in water every two or three hours. *Note* that belladonna may be given to children without fear. They are less susceptible to its use than adults.

The fungus containing muscarin is said to produce symptoms of intoxication, and symptoms of narcotic poisoning rather than of bowel irritation. Digitalis is also recommended as an antidote. Of its tincture 10 to 20 drops in water may be given repeatedly to an adult, 2 or 3 drops to a child.

The Morel (*Morchella esculenta*) grows in Britain, but is largely imported from Germany in a dry state. It is used for gravies.

Truffles (*Tuber cibarium*) are underground fungi, not growing at all above the surface. They are of a fleshy structure, dark in colour, covered with nodules, varying in size from a plum to a potato. They are found in Wiltshire, Hampshire and Kent in England, especially in oak and chestnut forests. Dogs are trained to un-

earth them, guided by the sense of smell, and in France hogs, which are very fond of truffle, are employed for the same purpose. The truffles chiefly sought after are black and white in colour. The table shows how these two varieties differ in chemical composition. It will be observed that both kinds contain a considerable quantity of nutritive material, much more than mushrooms. They are somewhat indigestible, and are principally used for stuffing and sauces.

LICHEN AND SEA-WEED.

Iceland-moss (*Cetraria islandica*) is a lichen, growing in high latitudes on barren rocks. Its composition is shown in the following table:—

Average percentage Composition of Iceland-moss.

Water	10·0
Nitrogenous	8·7
Starch	70·0
Acids	6·3
Fibre	3·5
Saline	1·5 (Church).

This table indicates that Iceland-moss is of very high nutritive value, and it is frequently made use of, in times of scarcity, by the inhabitants of the rocky coasts where it is found. The acids it contains give it a bitter taste. For use, therefore, it is prepared by steeping in water with a little soda, by which the bitterness is removed. Thereafter it is stewed in water, milk, or soup till it becomes tender and mucilaginous. A spirit may be distilled from Iceland-moss after fermenting the sugar, which may be obtained after transformation of the starchy ingredient. The starch may be transformed into sugar by boiling with weak sulphuric acid.

Reindeer-moss (*Cladonia rangiferina*) is also edible. It is found in mountainous parts of Britain, and in high northern latitudes where it forms almost the sole winter food for reindeer. It also forms a jelly-like substance when cooked.

Rock Tripe (Tripe de roche) is another edible lichen, resorted to for sustenance by Arctic voyagers in distress or by the Arctic hunters of North America.

Irish or **Carrageen Moss** (*Chondrus crispus*) is a sea-weed collected from the rocky shores of the north of Ireland, and found also on the rocky coasts of Britain. Its composition is given in the following table:—

Average percentage Composition of Carrageen Moss.

Water	18·8
Nitrogenous	9·4
Gum, &c.	55·4
Fibre	2.2
Saline	14·2 (Church).

The carbohydrate is in the form of a gummy material, which causes the moss, when steeped in boiling water, to form a stiff jelly. Before being cooked it should be steeped for some hours in cold water. The moss contains some iodine and sulphur, which render it useful in scrofulous conditions.

Laver is a general term applied to sea-weeds. **Green Laver** (*Ulva latissima*) is a common British sea-weed. *Porphyra vulgaris* and *laciniata* (sloke) are other species.

Sea-girdle (*Laminaria saccharina*), also called tangle and sea-wand, is abundant on British coasts. From it mannite, a sugary substance, is obtainable.

Bladder-lock (*Alaria esculenta*) is another sea-weed used as food. *Fucus vesiculosus*, bladder-wrack, has obtained some reputation for reducing corpulency. A liquid extract, called "Anti-Fat," has been advertised for this purpose. Many other sea-weeds, Ceylon moss, Chinese moss, Corsican moss, are also used for food. They are either boiled, after soaking in water, as already described, or pickled and eaten with pepper, vinegar and oil, or with lemon-juice.

II. Non-Nitrogenous Vegetable Foods.

STARCHES OR FARINACEOUS SUBSTANCES.

Starch is derived only from vegetable products. Preceding tables of composition show how abundantly it exists in grains, roots, and tubers, such as wheat, rice, potatoes, &c. In these substances it exists associated with nitrogenous material, but from this material it may readily be separated in a state of purity. For example, in the description of flour it has been shown how the starch may in a very simple way be separated from the gluten. In these food-stuffs the starch exists in the form of granules lying in compartments formed by a nitrogenous material. A starch granule consists of alternating layers of granulose and cellulose, both of which substances are starches; but the latter is extremely insoluble, while the former is dissolved by dilute acids and also by the ferments of the digestive tract. An envelope of cellulose is the outermost layer, and it is ruptured by boiling.

Starch Grains.—Under the microscope a typical starch grain appears as represented in the figure (Fig. 227), the concentric rings being the alternating layers of granulose and cellulose, and the point round which these rings circle is called the hilum. Now starch exists, as has

been said, in a great variety of structures; but the granule of starch varies in size and in appearance according to the plant from which it has been obtained. Thus the starch granule obtained from the potato is very easily distinguishable from that obtained from wheat; both are easily distinguished from the starch grain of Indian corn, and so on. Now the size of the starch grain of all the starches generally used has been very carefully and accurately measured and the appearances well determined, so that it is quite possible to take a mixture of several starches, and after microscopic examination to state definitely the sources of the various kinds in the mixture. If, for example, wheat flour has been adulterated with potato starch, the detection of this is quite easy. In the same way the different kinds of arrow-root can be readily determined under the microscope. The various kinds of starch grain in some of the commoner farinaceous substances are shown on p. 598.

Fig. 227.—Potato Starch Granules.

Starch consists chemically, as explained (p. 536), of carbon, hydrogen, and oxygen only, the hydrogen and oxygen being in proportions to form water. No nitrogen exists. Thus, while starch is eminently valuable for the liberation of heat and energy, by its carbon and oxygen uniting to form carbonic acid gas, and hydrogen and oxygen uniting to form water, it is of no value for the development or repair of tissues. The impossibility of any food-stuffs, such as corn-flour, arrow-root, &c., which consist almost entirely of starch, being made an exclusive food-stuff for any age, is therefore apparent. Starch grains when boiled with water swell up, the cellulose envelopes are ruptured, and the more soluble granulose allowed to come into contact with dissolving juices. After heating in this way starch becomes soluble. Heating to a high temperature converts starch into a form of sugar, and it undergoes a similar conversion when heated with certain acids. This transformation occurs rapidly when starch is brought into contact with ferments, such as the diastase of grain, the ptyalin (p. 143) of saliva, and a ferment in the pancreatic juice (p. 145). It is only when starch has undergone this conversion, either without or within the body, that it becomes useful for purposes of nutrition. Unless the starch granules have been swollen and ruptured by previous boiling with water this conversion cannot readily occur, because of the insoluble nature of the cellulose envelope. The proper cooking of starchy substances is, therefore, of vital importance.

Sago is the starch obtained from various species of palm. The chief are the sago palms (Fig. 228) (*Sagus Rumphii* and *Sagus lævis*), which grow in the islands of the Indian Archipelago, Madagascar, and New Guinea; but from *Cycas revoluta*, a tree common in India, Australia, and tropical America, a coarse sago is also prepared, as well as from other palm-like trees. The trees are cut down just before the appearance of the flower-bud, and the pith, in which chiefly the starch is present, is extracted and reduced to a coarse powder. It is then mixed with water, washed and strained, and the starch allowed to settle. The sediment is then dried, and is the sago flour. Before being sent to the market it may be put through various other processes. It is mixed with water and rubbed into the granular form, which is called granulated sago. Pearl sago is produced by other means, probably with the aid of heat. Sago bread is made by putting the dry meal into heated earthenware moulds, in which it becomes formed into a cake. The *Sagus lævis*, which yields the finest kind, grows in forests in the Moluccas. A single tree will yield as much as from 500 to 800 pounds of sago. Sago is never perfectly free from water, of which, indeed, it contains something like 18 per cent. It also contains 1 to 2 per cent of saline material, the remaining 80 per cent being dry starch. According to Dr. Ed. Smith there are

Fig. 228.—Sago-palm (*Sagus lævis*).

2555 grains of carbon in 1 lb. of sago;

that is to say, $\frac{4}{5}$ths of the pound of sago are pure starch.

Sago is a very bland food, easily digested, and wholesome, but, it must again be repeated, is entirely unsuited for a chief article of food because of its want of nitrogenous constituent.

Corn-flour or Indian-corn flour, is obtained from Indian corn (see p. 565). It is the starch

of the Indian corn, from which by various processes the nitrogenous constituent and bitter element have been removed. It still retains a trace of albuminous material, but not sufficient to be taken into account, in one sample only 18 grains being detected in one pound of the flour. Of pure starch it contains about the same quantity as sago.

Arrow-root is the starch obtained from the tuberous root of a West Indian plant, *Maranta arundinacea* (Fig. 229), now largely grown in Barbadoes, St. Vincent, and Bermuda. It was called the arrow-root plant, it is said, from the belief of the Indians that the root was an antidote to the arrow-poison, if the fresh roots were applied to the wound.

Fig. 229.—Arrow-root Plant.

The tubers when twelve months old are dug up, "well washed in water, and then beaten in large, deep, wooden mortars to a pulp. This is thrown into a large tub of clean water. The whole is then well stirred and the fibrous part wrung out by the hands and thrown away. The milky liquor, being passed through a hair sieve or coarse cloth, is suffered to settle, and the clear water is drained off. At the bottom of the vessel is a white mass, which is again mixed with clean water and drained; lastly, the mass is dried on sheets in the sun." The root furnishes about 26 per cent of starch. The Bermuda arrow-root is most esteemed. Other starches, sold as arrow-root, however, are made from quite different plants, and their source can always be determined by the use of the microscope.

English or **British Arrow-root** is potato starch.

Portland Arrow-root is starch made from the bulb of *Arum maculatum* (Fig. 230), the common "wake-robin," "cuckoo-pint," or "lords-and-ladies." It is manufactured in the island of Portland. An acrid material contained in the bulb is removed by washing.

Fig. 230.—Wake-robin (*Arum maculatum*).

Brazilian Arrow-root is the flour of *Manihot utilissima* (Fig. 232), from which tapioca is prepared—the cassava or tapioca plant, belonging to the natural order *Euphorbiaceæ.*

East Indian Arrow-root is obtained from the tubers of *Curcuma angustifolia,* one of the ginger family of plants, and a species of turmeric.

Tacca Arrow-root or **Tahitan Arrow-root** is derived from *Tacca oceanica,* a native of the South Sea Islands, of the order *Taccaceæ.* Another of the species, *T. pinnatifida* (Fig. 231), found in Asia, yields a starch much used by the natives.

Fig. 231.—Tacca pinnatifida.

Tous-les-mois or **Canna Arrow-root** is yielded by the tubers of *Canna edulis,* a native of the West Indies, of the same order as the plant which yields the true arrow-root, *Marantaceæ.* It is imported from St. Kitts.

Maize Arrow-root is the same as corn-flour.

Rice Arrow-root is the starch of rice, called also rice flour.

The same remarks apply to it as to other starches. It consists of about 82 per cent pure starch.

Tapioca or **Cassava** is the starch from the *Manihot utilissima,* already noted as the source of Brazilian arrow-root. It is a native of tropical America, and is also cultivated in India, Africa, and other tropical countries. The plants contain a bitter poisonous substance, which is removed by washing. The root is washed and scraped, and then reduced to a pulp by being rasped or grated. It is then squeezed to remove the juice. The pulp is then dried and forms cassava powder or manioc. Made into cakes it is called **cassava bread.** The cassava meal dried on hot plates forms irregular little lumps, and this is the tapioca.

Fig. 232.—Cassava Plant (*Manihot utilissima*).

Salep or Salop is the dried tubers of eleven species of orchid, *O. mascula* (Fig. 233), *maculata,*

latifolia, morio, and others. It is imported from Persia and Asia Minor, and is largely used in Turkey and Eastern Europe as food. It occurs in small oval bulbs, whitish-yellow in colour, hard, and semi-transparent, tasting like gum tragacanth, and with a faint peculiar smell. It is ground into powder and boiled with water, milk, and sugar, like other white-puddings. Its exact composition is not stated.

Fig. 233.—Salep (*Orchis mascula*).

SUGARS.

Sugar is a compound of carbon, hydrogen, and oxygen. There are two chief forms of it—the grape-sugars or glycoses, and the cane-sugars, sucroses or saccharoses. To the former class belong the fruit-sugar, to which specially the name glucose, glycose, dextrose, or grape-sugar is given, the sugar found in flesh called inosite, and it is the kind of sugar passed out of the body in the disease diabetes (p. 303). Laevulose, mannitose, galactose are other varieties of grape-sugar. Grape-sugars crystallize with difficulty forming warty little masses, or not at all, and in this they are markedly distinguished from the cane-sugars, which form beautiful crystals. The granular appearance of honey is due to the concretions of the grape-sugar of which it mainly consists.

Of cane-sugars the chief examples are derived from the sugar-cane, beet-root, and other roots, and the birch and maple. Milk-sugar, or lactose, the form in which sugar exists in milk, and maltose, a kind of sugar formed during the fermentation process in the transition to glucose, also belong to the cane-sugar group. Cane-sugar crystallizes readily in prismatic forms. It is more sweetening than grape-sugar.

Another distinguishing feature is that grape-sugar ferments readily; when submitted to the action of yeast it is transformed at once into carbonic acid gas and alcohol. On the other hand cane-sugar requires first to be converted into grape-sugar before it undergoes fermentation. Starch requires to be similarly transformed. In the human body both starch and cane-sugars require similar conversion, under the ferment action of the saliva or pancreatic juice, before they are available for purposes of nutrition. The starch is first transformed into dextrin, a gummy substance, having the same chemical composition as starch, and classed among the starches, but differing from it in being completely soluble in water, and then the transformation to glucose is effected. This same transformation of starch to dextrin, and dextrin to glucose, is effected by the action of the diastase of the wheat grain on the starch of the grain, produced during germination.

Cane-sugar.—The ordinary sugar of commerce is obtained from the sugar-cane (*Saccharum officinarum*), belonging to the natural order of the grasses, *Graminaceæ.* It is a native of India, whence it was transported to Cyprus about the middle of the twelfth century. From Cyprus it reached Madeira, and was transported to America about the beginning of the sixteenth century. It grows 18 to 20 feet in height, has jointed stems, has large firm thin leaves and numerous flowers (Fig. 234). When grown for

Fig. 234.—Sugar-cane.

1, Stem from entire plant in flourish. 2, Cane with leafy offset. 3, Piece of mature cane. 4, A spikelet of the flourish.

sugar, however, they are rarely allowed to come to flower, young plants being produced by offsets from the stem of older ones. It is in the stem of the cane that the sugar abounds, the composition of the stem showing—

Sugar	18	per cent.
Water	72·1	,,
Woody fibre and salts	9·9	,,

From many other plants may cane-sugar be obtained. The stem of the Chinese sugar-cane (*Sorghum saccharatum*) contains it to the extent of 9 to 9½ per cent. "A closely-allied species, called imphee, is grown by the Zulu Kaffirs, and yields not only sugar in its stems but much valuable starchy food in its seeds." The juice

from the stems of maize, cut shortly after flowering, contains cane-sugar to the extent of 3 to 4 per cent. The stems of the American rock-maple (*Acer saccharinum*) yield cane-sugar in richest quantity in early spring. Two holes are drilled in the tree about 20 inches from the ground, and wooden spouts driven into them, by which the ascending sap flows out into troughs placed to receive it. In this sap cane-sugar is present to the extent of 2 per cent. From the stem of the sago-palm (see p. 585) cane-sugar has also been extracted. **Jaggery** is the name applied to a sugar obtained from the juice of various palms, the cocoa-nut palm, the date-palm, the wild date-palm (*Phœnix sylvestris*), and *Caryota urens*, an inferior sago-palm. In roots and tubers of various other plants is it found. Chief of these is the beet-root, the sugar beet, or mangold-wurzel (*Beta vulgaris*). It yields 7 to 11 and even 14 per cent of cane-sugar. The manufacture of beet-sugar is largely carried on in France, Belgium, and Russia, a total of 700,000 tons of beet-sugar being, it is said, prepared in Europe annually, about half the total European import of cane-sugar. Cane-sugar may also be obtained from hazel-nuts, walnuts, coffee-beans, and locust-beans, carob-beans or St. John's bread, which contains it to the extent of 51 per cent (that is, the dry bean).

The following terse account of the method of preparing sugar from the cane is taken from Watt's *Dictionary of Chemistry.* The ripe canes cut close to the ground and stripped of the leaves are crushed between rollers, and the expressed juice, which is apt to run quickly into fermentation by the action of the albuminous matters which it contains, is purified by heating it in a copper boiler to about 140° Fahr., with a small quantity of lime. The impurities then form a scum, which is removed as fast as it collects. The juice, when sufficiently clarified, is rapidly concentrated to about 23° of the hydrometer, then passed through cloth filters and evaporated to a very thick syrup, which is run into shallow vessels to accelerate cooling, then poured into vessels having their bottoms pierced with holes which are kept plugged. The syrup, after being left at rest for some hours, is agitated to promote the crystallization of the sugar, and as soon as it has set into a solid mass, the plugs are removed to allow the still remaining liquid to run off, and the syrup is again boiled till it no longer yields any crystals. The last mother-liquors, which are thick, brown, and refuse to crystallize, are called molasses or treacle, and are used chiefly for the preparation of rum. The solid sugar, obtained as above, is sent to Europe under the name of raw sugar, or Muscovado sugar. It is a yellowish granular powder, still impregnated with treacle, and often contaminated with foreign substances, which impart to it a more or less disagreeable taste; hence it requires refining.

The formation of molasses is entirely due to the conversion of cane-sugar into uncrystallizable sugar by the heat to which the juice is subjected; the fresh juice of sound canes contains nothing but crystallizable sugar. Great improvements have recently been effected in the methods of boiling down syrups, especially by the use of vacuum-pans, whereby a beautiful crystallized product is obtained from the juice at the first evaporation, and the formation of molasses is greatly diminished. To obtain pure, colourless, crystallized sugar from raw sugar, the latter, dissolved in about a third of its weight of water, is mixed with a small quantity of milk of lime, and heated to the boiling point; and the juice is decanted from the impurities, which separate in the form of a crust, then filtered through bone-charcoal, and evaporated in a vacuum-pan. The strongly concentrated juice is made to crystallize by moderating the heat and running in small quantities of unthickened juice, whereupon a magma of sugar-crystals immediately forms. To give them the requisite hardness, heat is again applied, the crystalline magma is left to drain in the sugar-loaf moulds, and the formation of small uniform crystals is promoted by stirring and breaking up the crust which forms on the surface. When the crystallization is complete, the apex of the mould, which has previously been closed, is opened, to allow the syrup to drain off, and that which remains adhering to the crystals is displaced by pouring in pure sugar syrup. By due desiccation (drying) the loaf-sugar or refined sugar of commerce is obtained.

Formerly the clarification of the syrup was effected by adding a certain quantity of the serum of bullocks' blood; on heating the syrup, the albumen of the serum became coagulated and rose to the surface, carrying with it the greater part of the impurities.

When it is not desired to make loaf-sugar the uncrystallizable syrup is removed by centrifugal machines, revolving drums covered with fine wire-gauze, caused to turn with great speed, by which the syrup is thrown out through the gauze, while the sugar is retained in the drum.

In the refining process treacle and golden syrup are obtained. Treacle is the uncrystal-

lizable portion separated from the crystals in the draining process. It contains water, some crystallizable sugar in solution, saline matters and impurities, and about 65 per cent of uncrystallizable or fruit sugar, due to conversion of cane into fruit sugar by the heat. Syrup is clarified treacle, obtained by re-boiling the treacle and filtering through animal charcoal. Coloured moist sugars are less refined qualities, containing more water, uncrystallizable sugar, and various impurities. Sugar in the largest crystals is of the purest kind; sugar-candy is the purest kind of sugar. There is always a proportion of water in sugar, roughly indicated by the degree of moisture. The purest white sugar contains 99·92 per cent of sugar, the remainder being ·069 per cent of absorbed moisture, 1·02 per cent of ash. In inferior qualities the quantity of sugar may be reduced to 94, 88, 80, and 67 per cent. The sweetening qualities of sugar will, therefore, vary; and the diminished sweetening quality of the inferior kinds is marked, because of the considerable proportion of fruit-sugar they contain, whose sweetening property is much less than that of cane-sugar.

There are 2800 grains of carbon in 1 pound of moist sugar.

Caramel is produced from cane-sugar by heating to 1600° Fahr., by which water is driven off, the sugar ceases to be able to crystallize, is dark coloured, and becomes bitter in taste. It is used by cooks for flavouring and colouring.

Honey is a vegetable product. It is the sweet juice produced in the nectaries of plants at the base of the petals. It appears simply to be collected and stored by the bees, and not to undergo any chemical change while it remains in the honey-bag of the bee, which is a dilatation of the gullet or œsophagus. The quality of the honey is therefore mainly affected by the nature of the plants from which it is obtained. "In Scotland the best honey is gathered in the months of June and July, when the white clover (*Trifolium repens*) is in bloom; and what is stored in spring, or rather in April and May, is finer and better flavoured than what is obtained in autumn, unless the bees have been during the latter season within reach of heath, the honey from which is of a rich wild flavour, but of a darker colour. The quality of honey is, of course, much influenced by the nature of the plants most frequented by the bees. The famed honey of Hymettus derives its excellence, it is said, from the wild thyme growing so luxuriantly on the celebrated mountain from which it derives its name; that of Narbonne, from the wild rosemary (*Rosmarinus officinalis*). The white Dutch clover and the heath have been already noticed as furnishing honey of a superior kind; and there is a district in Galloway, North Britain, where perhaps the best honey in the kingdom is produced, owing, it is supposed, to the great abundance of wild thyme (*Thymus serpyllum*) with which the country abounds." Honey of a deleterious nature is sometimes met with. "Towards the close of the year when flowers become scarce, and in those parts of the country where alders abound, and where onions and leeks are cultivated on a large scale, and allowed to run to seed, the bees, from taste, or from necessity, or from anxiety to complete their winter stores, are seen to feed on these plants, which communicates to the honey a very disagreeable flavour. But this is not all. The fact stated by Xenophon in the *Retreat of the Ten Thousand*, and confirmed by Diodorus Siculus, proves that there are plants in Asia Minor which give to the honey, not only disagreeable, but poisonous qualities. He tells us that the soldiers, having eaten a quantity of honey in the environs of Trebizonde, were seized with vertigo, vomitings, &c. This effect was attributed to the rose-laurel (*Rhododendron ponticum*), and yellow azalea (*Azalea pontica*). Father Lamberti also assures us that a shrub of Mingrelia produces a kind of honey which causes very deleterious effects. It is quite possible that the poisonous juices extracted from these plants might be innocuous to the bees themselves. . . . Sir J. E. Smith asserts that the nectar of plants is not poisonous to bees, and an instance is given, in the *American Philosophical Transactions*, of a party of young men who, induced by the prospect of gain, having removed their hives from Pennsylvania to the Jerseys, where there are vast savannahs, finely painted with the flowers of the *Calmia angustifolia*, could not use or dispose of their honey on account of its intoxicating quality; yet 'the bees increased prodigiously;' an increase only to be explained, says Dr. Bevan in his *Honey-Bee*, by their being well and *harmlessly* fed."

Bees are found in all temperate and warm climates. The bee cultivated in Europe is the *Apis mellifica;* the red honey of Surinam and Cayenne is produced by the *Apis amalthea;* and in Madagascar honey of a greenish colour is obtained from the *Apis unicolor*, a black bee.

Honey consists of cane-sugar, fruit-sugar or glucose, and inverted sugar (a mixture of two varieties of glucose, namely dextrose and lævu-

lose). Along with these there is also a trace of flavouring and colouring substances and wax. There are also pollen from the plant "and invariably minute quantities of alcohol." The total quantity of sugar, mainly grape or fruit sugar, is not less than 73 per cent, and there is not more than 27 per cent of water.

Virgin Honey is the term applied both to honey from young bees that have never swarmed, and to honey obtained from the comb without the aid of heat or pressure, simply by allowing it to drain from the comb.

Honey which has been kept for some time, or has been obtained from the comb by the aid of pressure and heat, crystallizes owing to the formation of the small warty masses of dextrose. It is less delicate in flavour than clear virgin honey.

Mead, or metheglin, is an alcoholic liquor obtained by the fermentation of honey, varying in sweetness according to the extent to which the fermentation has been carried. It was a drink much consumed in England in olden times.

Manna is a sugary exudation from certain plants and trees, especially of the ash tribe. The manna of commerce is obtained chiefly from two kinds of ash, *Fraxinus ornus* and *Fraxinus rotundifolia*, by making incisions in the stems of the trees. The juice escapes and dries into crystalline masses, which are collected. The trees are cultivated for the purpose chiefly in Sicily and Calabria. A similar substance can be obtained from the common ash (*Fraxinus excelsior*). Other sugary exudations, known under the name of manna, are obtained from other sources, Briançon manna from the leaves of the common larch (*Larix europœa*), another from Mount Lebanon, from the branches of *Pinus cedrus*. Manna is also yielded by the *Eucalyptus mannifera*, the dwarf oak, tamarisk, and other plants. That of the last named is called **Manna tamariscina**, or **Manna Israëlitarum**, and is believed by Landerer to be the manna mentioned in the Old Testament. "He informs us that this exudation is produced by the puncture of *Coccus manniferus*, an insect inhabiting the trees of *Tamarix mannifera*, which grow abundantly in the neighbourhood of Mount Sinai. The manna exudes as a thick transparent syrup, covering the smaller branches from which it flows. It is collected by the monks of the district in the month of August. The collection takes place very early in the morning, at which time, owing to the coolness of the night, the saccharine juice has become to some extent congealed. The tamarisk manna is eaten in Palestine and in the district of Sinai as a delicacy." The manna may be shaken from the trees on which it has collected before sunrise, into cloths spread underneath. It is also found upon sand and stones; and in the state in which it is found it resembles coriander seed. **Honey-dew** is a similar sugary exudation found on many plants, principally oak, elm, plane, lime, beech, and fruit trees and evergreen plants. It is found at the close of summer on very sultry evenings.

Manna consists largely of a peculiar kind of sugar, called mannite; according to one authority 60 per cent is mannite, and a large percentage of uncrystallizable sugar; according to another analysis the tamarisk manna consists of cane-sugar 55 per cent, inverted sugar 25 per cent, and dextrin (a gum) 22·5 per cent.

It has an aromatic flavour, and is now chiefly used as a mild laxative for children, from 60 grains up to ½ ounce being the dose.

VEGETABLE OILS.

Oil is yielded by a very large number of vegetable products, from nuts like the palm-nut, the walnut, almond, hazel-nut, ground-nut, from other fruits like the olive, and especially from seeds, such as those of the cotton plant, mustard seed, cucumber seed, rape seed, &c.

To understand the richness of some of these in oil reference need only be made to the tables on pages 580 and 582, where it is found that the quantities of oil yielded by 100 pounds of the substances are very great. Thus—

100 pounds of			
Filberts	yield over	66	pounds of oil.
Walnuts	,,	62	,,
Almonds	,,	53	,,
Ground-nuts	,,	50	,,
Cocoa-nuts	,,	35	,,

To these we may add the following—

100 pounds of			
Palm-nut (pulp)	yield	72	pounds of oil.
Sesame seeds	,,	51	,,
Olives (kernels)	,,	44	,,
Linseed	,,	38	,,
Cotton seed	,,	24	,,
Sunflower seeds	,,	22	,,

Olive-oil is expressed from the pulp of the ripe olive, the fleshy exterior of the fruit. The common olive-tree (*Olea europœa*, Fig. 235) is a native of Syria, and is cultivated in Italy, France, Spain, Turkey, &c. It is a pure bland oil, well suited for domestic purposes. The first

oil pressed from the ripe fruit is greenish in colour, and is the finest—virgin oil it is called. Provence oil (produced in Aix), Florence oil, Lucca oil, Genoa oil, and Gallipoli oil, are all olive-oils of good quality, the first being most esteemed. Sicily oil is also olive-oil of an inferior quality, and Spanish oil is the worst kind, being used for machinery. The olive fruit itself is not only used for obtaining oil but is preserved as a pickle, and used after dinner to refresh the palate for the taste of wine. The fruit is pickled while still green—the ripe fruit is black—it is soaked in strong soda solution to remove a bitter principle, then in fresh water, and afterwards transferred to a solution of salt in which it is preserved.

Fig. 235.—Olive (*Olea europæa*).

Palm-oil is mainly used in Britain as a lubricant. It is, however, used on the Gold Coast as a butter, and when pure and fresh is wholesome. It is obtained from several species of palm, chiefly the oil-palm, *Elæis guineensis* (Fig. 236), the oil being expressed from the fruit, palm-nuts.

Fig. 236.—Palm-oil Tree (*Elæis guineensis*).

Fig. 237.—*Sesamum orientale* (Sesame).

Sesame-oil is a fine bland oil, used in India as an article of food, and elsewhere for burning in lamps, as well as for adulterating olive-oil. It is expressed from the seeds of *Sesamum orientale* (Fig. 237), natural order *Pedaliaceæ*, native to India and also cultivated in Egypt and Syria.

Cotton-seed Oil, unlike linseed-oil, is an extremely pleasant oil, and fitted to be used as a food-stuff. It is cheaper than lard, and might with great advantage be used instead of it for cooking in oil. "The very best lard," Williams says, "or ordinary kitchen butter, eaten cold has more of objectionable flavour than refined cotton-seed oil." Moreover, the present price of the best refined cotton-seed oil is 3½*d.* per lb., while lard costs 6*d.* per lb. wholesale. It is expressed from the seeds of *Gossypium barbadense,* of the natural order *Malvaceæ.*

Cucumber-seed Oil. Common cucumber (see p. 574) seeds also yield an oil, said to be of delicious and delicate flavour, and the large cucumber grown on the African coast yields from its seeds an oil which "far exceeds in flavour the finest olive-oil."

Shea or **Galam Butter** is a vegetable fat obtained from the nuts of *Bassia Parkii,* of the natural order *Sapotaceæ,* natives of India, Africa, and America. The sapodilla plum is the produce of a species of the same order, which is rich in trees and shrubs useful for alimentary purposes. A species of the same order is the tree which produces the gutta percha of commerce, *Isonandra gutta.* The nuts of *Bassia Parkii* are shelled, and the kernels, which consist almost wholly of fat, are boiled with water and pressed. The fat is greenish white, and solid at ordinary temperatures, and has a mild pleasant flavour. Many other kinds of Bassia yield oils which, in the Gaboon and elsewhere where they are produced, are used by the natives as an external application for rheumatism.

III. Condiments.

Condiments are substances which are not foods in themselves, but are taken with foods for the purpose of aiding their flavour.

The chief condiment is salt. It, however, stands on quite a different level from the others. It is a necessity, and its importance has been already dwelt on (p. 539). The other condiments we might classify in the following way:—

Acids: Vinegar, lemon-juice, pickles, &c.

Pungent substances: Pepper, mustard, ginger, curry, horse-radish.

Aromatics: Cinnamon, nutmegs, cloves, allspice, mint, mace, parsley, cardamoms, thyme, caraway, coriander, angelica, marjoram, fennel, dill, anise, sage, vanilla, turmeric, chervil, cumin, capers, onion, garlic, shallot, chives, savory, tarragon.

None of these is necessary for foods. They are added for the purpose of giving a fillip to the appetite, and where there is any feebleness of appetite they cause more food to be eaten

than would otherwise be. They also relieve the monotony and sameness of food, and where natural appetite is wanting they act beneficially in this way. They also act upon the mucous membrane of the stomach, and stimulate the flow of blood to the glands and of gastric juice; and thus undoubtedly they will stimulate digestion, where such stimulation is needed. Vinegar, by the addition of acid which it makes, will also further aid digestion where the acidity of the gastric juice is too feeble. In a state of health, however, there is no need for such stimulation, and if they are resorted to, to any great extent, specially the more active condiments, the stomach and bowels are likely to become so used to their sharp stimulating action that they will not respond to any less active stimulant. The mere entrance of the food into the stomach is, in health, the only incitement required to promote the flow of the gastric juice, but will be totally insufficient for the stomach accustomed to the rousing action of spices, curries, and aromatics of various kinds. They ought, therefore, always to be employed with great moderation, and the milder of them rather than the more active and pronounced. They should not be permitted to children at all.

Vinegar owes its acid properties to acetic acid, of which it ought to contain 5 per cent, that is, 5 per cent of the pure crystallizable acetic acid, which is also called glacial acetic acid. There are two chief processes by which vinegar is made. The first is by conversion of alcohol into acid, which is effected by the acetic acid fermentation, now known to be due to the activity of an organism, the *Mycoderma vini*, just as alcohol is the result of a fermentation due to the activity of another organism, the *Torula cerevisiæ* (p. 389). So that vinegar is made from sugar, or starch which has been converted into sugar, after it has undergone two fermentations, first into alcohol and second into acid; and the souring of wines is the result of the production of acid by the agency of organisms which have gained access to the wine. The material from which vinegar is produced by this fermentive process is either wine or malt, and thus there are **Wine-vinegar**, produced on a large scale in France, and **Malt-vinegar**, produced in England. The second process is by the destructive distillation of wood. This produces **Wood-vinegar, or Pyroligneous Acid.** The flavour of the particular vinegar depends upon its source. For, besides the 5 per cent of pure acetic acid which it ought to contain, and water, which makes up almost the remainder of its bulk, there are present in minute quantity various substances dependent upon the source of the vinegar, which give it the special flavour it may possess, as well as salts, extractive matter, alcohol, sugar, gum, and probably some colouring matter purposely added by the manufacturer. Flavouring essences are also frequently added.

Wine-vinegar is prepared from grape juice and inferior new wines, that made from white wine is specially desired. The wine is kept in large casks at a fixed temperature, and the fermentation occupies generally a fortnight. Thereafter the vinegar is run off into barrels, in which are several chips of birch wood, and there clarified. Or the wine is placed in large casks containing beech shavings, which afford space for the growing organism, and when the wine has become converted into vinegar, half is run off and the cask then filled up with more wine, so that the "mother" casks, as they are called, are never emptied, and the process of manufacture goes steadily on.

Malt-vinegar is obtained from a mixture of malt and raw barley, mashed with water, and allowed first to undergo the vinous fermentation, and subsequently the acetic acid fermentation. A long time—weeks or months—is occupied in the process.

Vinegar may, of course, be made from sugar by submitting it to the double fermentation. It might, therefore, be called **sugar-vinegar.**

Wood-vinegar is made by heating wood in large iron cylinders, which are connected with condensers. The liquid which passes over from the cylinders consists of wood spirit, acetic acid, water, and tarry products. By redistillation the pyroligneous acid is separated out in a crude state, containing tarry matter. By various chemical processes the acetic acid is separated from the tar by conversion into acetate of sodium, the acetic acid then liberated by decomposition with strong sulphuric acid, and finally purified by distillation.

Vinegar usually contains some sulphuric acid, added to prevent decomposition, though that has been shown to be unnecessary, and allowed by law to the extent of one-thousandth part by weight. It is usually sold in four degrees of strength, called Nos. 18, 20, 22, and 24, of which the last is the strongest, and is the best for pickling. No. 22 is the best for the table.

Vinegar is used by itself, also in the preparation of sauces, and for the making of pickles, for which all kinds of vegetables may be used. Copper has been added to vinegar in order to give the vegetables a bright green colour. It

is, of course, injurious, and its presence may be detected by inserting the bright blade of a steel knife, which will become coated with the coppery colour. It is useful for allaying thirst and checking excessive perspiration. It is a popular remedy for corpulence, and does, when habitually taken, cause diminution of stoutness to occur, but by interfering with the digestive process and producing a failure of nutrition. Used regularly for such a purpose it is undoubtedly hurtful.

Lemon and **Lime Juice** owe their special properties to the presence of citric acid, which is found also in the citron, orange, shaddock, and other fruits. It is prepared in England, and also in Sicily and the West Indies, some brandy being added to the juice to preserve it, and sometimes it is preserved by simple boiling. The juice should contain 32½ grains of citric acid in each fluid ounce, and with it there is malic acid, gum, extractives, and water. It is an agreeable and refreshing beverage, and is regularly employed in the merchant navy as a preventive of scurvy, 1 ounce of juice, 1 ounce of sugar, and half a pint of water being daily served out to each of the crew. An artificial lemon beverage may be prepared by dissolving 552 grains of citric acid in a pint of water and flavouring with essence of lemon; or the following: 1¼ oz. citric acid, 45 grains carbonate of potash, 2½ oz. white sugar, dissolved in 1 pint of cold water, flavoured with essence of lemon or the rind of a lemon, and after 24 hours strained through a hair-sieve or piece of muslin.

Pepper is the fruit of a set of herbs belonging to the natural order *Piperaceæ*, or pepperworts, which flourish in the tropics. **Black-pepper** is the fruit of *Piper nigrum* (Fig. 238), dried while still unripe. The plant is a climbing one, supporting itself on other trees, and growing to a height of 8 to 12 feet. Its berries pass from the green to the red stage and then become black, but previous to this they are gathered and dried in the sun; they occur in small clusters, 20 to 50 in each. **White-pepper** is the same fruit deprived of its outer husk. The best black-pepper comes from Malabar; but what is sold in the shops consists of a mixture of berries from different localities—Malabar, Penang, Sumatra, &c. **Long-pepper** is the fruit of *P. longum* (Fig. 239), native to Java, Malabar, and Bengal. **Jamaica-pepper**, or **Allspice**, or **Pimento** (Fig. 240), is the berry of *Eugenia pimenta*, belonging to the *Myrtaceæ* order, to which cloves, cajeput, guava, and eucalyptus belong. It is imported from Jamaica. Its peculiar aroma, supposed to resemble a mixture of cinnamon, cloves, and nutmeg, have earned for it the name of allspice. **Cayenne-pepper** is made from the powdered pods of *Capsicum annuum*, of the same order as potato, *Solanaceæ*. It is sold entire under the name of **Chillies**. It is native to America, and is imported chiefly from Zanzibar and Natal. Guinea-pepper, cherry-pepper, bell-pepper, goat-pepper are all obtained from different kinds of Capsicum.

Fig. 238.—Black-pepper (*Piper nigrum*).

Fig. 239.—Long-pepper (*Piper longum*).

Fig. 240.—Pimento.

All these substances owe their peculiarities to the presence of an essential oil, which in black and white pepper exists to nearly 2 per cent.

Mustard is the finely ground seeds of *Sinapis nigra* or *alba*, black or white mustard, or a mixture of both. They belong to the cruciferous order. From the white mustard 36 per cent of a clear yellow odourless oil, void of all pungency, can be expressed, and from the black mustard 18 per cent. If the flour, left from the black mustard, be moistened with water a volatile oil is formed, which did not previously exist, to which the pungent qualities are due, and which is developed, owing to the moistening, from a substance called myronic acid. White mustard contains no such acid, and does not develop pungency by moistening. This volatile oil is produced only to the extent of ·2 per cent.

Fig. 241.—Mustard (*Sinapis nigra*).

Horse-radish (p. 572) belongs to the same order as mustard, and yields a volatile oil similar to that of black mustard.

Ginger is the scraped and dried root of *Zingiber officinale* (Fig. 242), of the order *Zingiberaceæ*, tropical plants, widely cultivated in East and West Indies, China and Africa.

Fig. 242.—Ginger Plant (*Zingiber officinale*).

Curry of Ceylon is said to be a mixture of the following: a piece of green ginger, two fragments of garlic, a few coriander and cumin seeds, six small onions, one dry chilli, eight peppercorns, a small piece of turmeric, half a dessert-spoonful of butter, half a cocoa-nut, and half a lime; to have it in perfection it should be made on the day on which it is to be cooked. Ordinary curry powder is a mixture of turmeric, black-pepper, coriander seeds, cayenne, fenugreek, cardamoms, cumin, ginger, allspice, and cloves.

Belonging to the ginger order are some of the aromatic condiments.

Turmeric is an example, the root-stock of *Curcuma longa*, an East Indian plant, imported chiefly from Bengal and Peru. It is used both as a dye, of a yellow colour, and also as a condiment in powder. Its odour is due to an essential oil, which it contains to the extent of 1 per cent.

Cardamoms are also aromatic fruits of the ginger order. The medicinal cardamoms are derived from *Elettaria* (*Alpinia*) *Cardamomum*, Malabar cardamoms. A large kind (*Amomum angustifolium*) comes from Madagascar, a smaller (*Amomum cardamomum*) from Sumatra. **Grains of Paradise** or Ceylon cardamoms belong to the same order, and are the fruit of *Amomum melegueta*, a West African plant.

Of the aromatic group the following belong to the natural order *Umbelliferæ*:—

Parsley (*Apium Petroselinum*) is a native of Sardinia, yielding both a fixed and volatile oil.

Fennel (*Fœniculum vulgare*) grows wild on the Mediterranean shores, of which both seeds and leaves yield an essential oil: chopped leaves are sometimes served in melted butter to mackerel: cordials are flavoured with the fruit.

Cumin (*Cuminum cyminum*) is native to Egypt and Syria; the essential oil of cumin is used for flavouring cordials, and is obtained from the seeds: cumin resembles fennel.

Dill (*Anethum graveolens*), native to Southern Europe, very much resembles fennel. Its essential oil dissolved in spirit yields, when diluted with water, dill water, a useful and harmless agent for dispelling wind from the bowels of children.

Anise (*Pimpinella anisum*) is native to Asia Minor and Egypt, and cultivated in Spain and Malta. The fruit contains 2 per cent of essential oil, used for flavouring cordials: sugar flavoured with the oil is used for flatulence.

Caraway (*Carum Carui*) has a root like carrot or parsnip, and may be used as they are: seeds are imported from Holland: an essential oil is yielded by the seeds, and is used for flavouring cakes, confectionery, cordials, &c.

Fig. 243.—Coriander (*Coriandrum sativum*).

Coriander (*Coriandrum sativum*), native to Southern Europe, is cultivated in France: the seeds are used and yield also an essential oil.

Angelica (*Archangelica officinalis*), found in Northern Europe, possesses a large fleshy aromatic root, which is boiled in syrup and used as a sweetmeat; the seeds are used as flavouring agents for cordials, &c.

Chervil (*Anthriscus cerefolium*) or garden chervil, native to Britain, a hairy herb, is used for flavouring soups and salads; sweet chervil is *Myrrhis odorata.*

The natural order *Labiatæ* yields a large number of sweet, savoury, or pot herbs:—

Mint or **Spearmint** (*Mentha viridis*) and peppermint (*M. piperita*) and pennyroyal-mint (*M. pulegium*) all yield essential oils.

Thyme (*Thyma vulgaris*), a Mediterranean shrub; wild thyme (*T. Serpyllum*) is a British plant: the essential oil is called origanum oil.

Marjoram (*Origanum vulgare*) is a native of Britain: sweet marjoram is *O. marjorana,* and is much used for culinary purposes because of its fragrance.

Sage (*Salvia officinalis*), native of Southern Europe, is a garden plant; wild sage (*S. Verbenaca*) is a native of Britain, and also meadow-sage (*S. pratensis*).

Sweet Basil (*Ocymum basilicum*), native of India, is specially used in France for flavouring soups, sauces, &c., like the other pot-herbs.

Savory (*Satureia hortensis*) is a garden shrub cultivated in Europe for seasoning sauces.

To the order *Liliaceæ* belong the following:—

Garlic (*Allium sativum*), a bulbous perennial, native to Southern Europe, much resembles onion, but is of stronger flavour and odour: the

bulb consists of ten or twelve "cloves" inclosed in a tough coat.

Shallot or **Eschalote** (*Allium ascalonicum*) is a native of Palestine, especially near Ascalon: it is one of the mildest of the onion tribe.

Chives or **Cives** (*Allium schœnoprasum*) is native to Britain, and is used as are leeks or onions.

Capers are the flower-buds of *Capparis spinosa*, of the natural order *Capparidaceæ*, growing in the south of Europe: it is a low wall

Fig. 244.—Caper (*Capparis spinosa*).

Fig. 245.—Cinnamon (*Cinnamomum zeylanicum*).

plant, of which the flower-buds are collected before expanding and placed in vinegar.

Cinnamon and **Cassia** are derived from the bark of a tree of the genus *Cinnamomum*, of the order *Lauraceæ*. The former is yielded by *C. zeylanicum*, an evergreen tree of Ceylon, Borneo, Sumatra, and the coast of Malabar. It is in the form of quills, the inner bark stripped from two-year-old shoots. Cassia is a Chinese species, the unripe fruit of which is "cassia buds." White cinnamon comes from a different order, being the bark of a West Indian tree, *Canella alba*, of the order *Canellaceæ*. It is also an aromatic.

Nutmegs are the kernel of the fruit of *Myris-*

Fig. 246.—Nutmeg (*Myristica moschata*).

tica fragrans, of the order *Myristicaceæ*. The nut is within the fleshy fruit, and is surrounded by an arillus or extra covering. This when dried and ground, is known as **Mace**. The tree grows in the East and West Indies, Banda Isles, Sumatra, Brazil, &c. The nutmeg yields 6 per cent of an essential oil of a powerfully aromatic taste. Mace yields 4½ per cent of an aromatic oil.

Cloves are the dried flower-buds of *Eugenia caryophyllata*, of the myrtle order. It is a handsome evergreen tree, native to the Moluccas, and cultivated in Zanzibar and West Indies. The buds are rich in a volatile oil—oil of cloves—yielded by other parts of the plant also.

Fig. 247.—The Clove Plant.

Tarragon (*Artemisia dracunculus*) belongs to the *Compositæ* order, native to Siberia, and cultivated in France. Wormwood belongs to the same species; also mugwort and southernwood. In France it is used for flavouring vinegar and salads.

Vanilla, so much used in the form of an essence for flavouring purposes, is derived from the pods of an orchid, specially *Vanilla planifolia*, native to tropical America. It can now be made artificially from pines.

Fig. 248.—Vanilla.

Animal and Vegetable Foods Compared.

It will now be of interest to contrast animal and vegetable foods from the point of view of their nutritive value so far as that is indicated by their chemical composition. This will be best done by taking typical foods representative of each class. The following table shows the composition of various foods, selected from tables already given, and chosen because of their representative character. The water, saline constituents, fibre, &c., have been omitted, and only the percentages of the useful nutritive ingredients given.

Average Percentage Composition of various Animal and Vegetable Foods.

	Lean Beef.	Fowl.	Eggs.	Cows' Milk.	White-fish.	White Bread.	Scotch Oatmeal.	Haricot Beans (dried).	Potato.	Cabbage.	Figs (dried Turkey).	Sago.
Nitrogenous	19·3	22·65	14·0	4·65	18·5	6·82	16·1	20·81	2·3	1·89	6·1	—
Carbo-hydrates (sugar, starch, &c.)	—	—	0·0	4·28	—	52·34	63·0	53·63	19·7	4·87	65·9	80·0
Fat	3·6	3·11	11·0	3·50	3·0	·77	10·1	2·28	0·3	0·20	0·9	—
Totals	22·9	25·76	25·0	12·43	21·5	59·93	89·2	76·72	22·3	6·96	72·9	80·0

If now, using this table, we reckon up the total nutritive material contained in each of these materials, and, instead of expressing the result in percentages, express it per pound, we get results tabulated in the table that follows.

Total Nutritive Material in 1 lb. of the following Substances:—

Oatmeal	·892 of a lb.,	or fully	$14\frac{1}{4}$	ounces in the lb.
Sago	·800	,, ,,	$12\frac{3}{4}$	,,
Haricot beans....	·767	,, ,,	$12\frac{1}{4}$	,,
Figs	·729	,, ,,	$11\frac{1}{2}$	,,
White bread	·599	,, ,,	$9\frac{1}{2}$	,,
Fowl	·257	,, ,,	$4\frac{1}{10}$	,,
Eggs	·250	,, or exactly	4	,,
Beef	·229	,, or fully	$3\frac{1}{2}$	,,
Potato	·223	,, ,,	$3\frac{1}{2}$	,,
Fish	·215	,, or barely	$3\frac{1}{2}$	,,
Milk	·124	,, ,,	2	,,
Cabbage	·069	,, ,,	$1\frac{1}{10}$	,,

This method of estimating total nutritive ingredients in the pound is not, however, entirely satisfactory, as a glance at the table shows. Oatmeal reigns there pre-eminent, and rightly so. Tested in any way one pleases, it maintains its pre-eminence as the most nourishing food that can be found, as a half more nourishing than white bread, weight for weight, and twice more nourishing than beef. But this method of calculation places sago second in the list, and that pre-eminence is undeserved. It is quite true that one pound of sago contains $12\frac{3}{4}$ ounces of nutritive material, but that is entirely in the form of starch, no albuminoid material being present, so that, while of great value as an energy-producing food, it is useless for tissue repair. If, then, we separate out the total nutritive material, and estimate how much of it is nitrogenous or albuminoid material, and how much is fat and carbo-hydrate, we shall see at once the relative value of the different foods (1) for tissue growth and repair, and (2) for liberation of energy—fats and carbo-hydrates going together for this purpose. The result is shown in the next tables.

Tissue-forming Material in 1 lb. of the following Substances:—

Fowl	$3\frac{6}{10}$ ounces per lb.
Haricot beans.........	$3\frac{3}{10}$,,
Beef......................	3 ,,
Fish......................	$2\frac{6}{10}$ ounces per lb.
Oatmeal................	$2\frac{1}{2}$,,
Eggs	$2\frac{1}{4}$,,
Bread......................	1 (fully) ounce per lb.
Figs......................	1 (scarcely) ,,
Milk	$\frac{3}{4}$ (barely) of an oz. per lb.
Potato..................	$\frac{4}{10}$,, ,,
Cabbage................	$\frac{3}{10}$,, ,,
Sago	Nothing.

Energy-yielding Material in 1 lb. of the following Substances:—

Sago......................	$12\frac{8}{10}$ ounces per lb.
Oatmeal................	$11\frac{7}{10}$,,
Figs......................	$10\frac{7}{10}$,,
Beans	9 (barely) ,,
Bread....................	$8\frac{1}{2}$,,
Potato..................	$3\frac{2}{10}$,,
Eggs	$1\frac{3}{4}$,,
Milk......................	$1\frac{1}{4}$,,
Cabbage	$\frac{8}{10}$ of an ounce per lb.
Beef......................	$\frac{1}{2}$ (fully) ,,
Fowl......................	$\frac{1}{2}$ (barely) ,,
Fish	$\frac{1}{2}$,, ,,

We may observe further that if complete justice were to be done in such a comparison as this, a distinction would require to be drawn between those food-stuffs whose energy-yielding material consisted largely of fat, and those whose energy-yielding material consisted almost exclusively of starch. We have seen (p. 532) that, weight for weight, fat yields fully twice the energy that starch does. Thus the $12\frac{3}{4}$ ounces of energy-yielding material in sago are all starch, while in oatmeal of the $11\frac{7}{10}$ths energy-yielding substance, $1\frac{6}{10}$ths are fat. Counting the $1\frac{6}{10}$ths fat to be equal to $3\frac{2}{10}$ths starch (and it is fully that), then the oatmeal would contain really $13\frac{2}{10}$ths energy-yielding material as starch, and would thus head the list. In the same way eggs would take a much higher place, because its $1\frac{3}{4}$ ounces of energy-yielding substance are all fat, equal to something like 4 ounces of starch, or even more. They would thus rank above potatoes, whose energy-containing material is almost exclusively starch. Beef, fowl, &c., would thus also take higher places, because of the 3 to $3\frac{1}{2}$ per cent of fat they contain.

The result of such a comparison is to show

that the vegetable foods contain the greatest amount of nourishment in a given weight, and to give them a position as energy-yielding foods to which none of the animal foods can approach, but also to indicate that animal foods possess a value for growth and repair of tissue which excels all vegetable foods, and is only approached by beans (and, of course, foods of the same kind, such as peas and lentils) and oatmeal.

We must not, however, stop at this point. These considerations arise from viewing the chemical composition of the various food-stuffs. We must not forget to consider them from the point of view of the human body, which desires to extract from them this nourishment which they contain; in short, we need to consider the digestibility of the various materials. The result is to modify very materially the position that chemical considerations give to some of the vegetable foods, and notably to beans, peas, &c. In particular, the tissue-repairing material they contain is less readily extracted from them than from most animal foods, and the extraction involves greater waste material to be expelled. When such considerations, and they are detailed on p. 604, are taken into account, the inevitable conclusion is that for the yielding of material for growth and repair of tissues animal foods are unapproached except by oatmeal.

THE ADULTERATIONS OF FOOD-STUFFS, AND UNWHOLESOME FOOD.

Adulteration consists in the addition of some substance foreign to the food-stuff, not acknowledged in its sale and not necessary for its manufacture or preservation. Such substance is usually added to increase the profit on the sale of the article by adding to its weight, such as water injected into beef or added to milk, and plaster of Paris added to flour; or an inferior and cheaper article is added closely resembling the fine quality, such as potato starch to flour or St. Vincent arrow-root, or margarine to butter; or the adulteration is for the purpose of enhancing the appearance of the article sold, such as alum to give whiteness to bread, or copper to brighten the appearance of preserved green vegetables, or colouring matter such as annatto to butter.

The detection of adulteration and its nature are the work of expert chemists, but a few simple domestic methods for some of the best-known articles may be usefully mentioned here.

The detection of the addition of water to milk has been mentioned on p. 551, and to butter on p. 556. The presence of solid matter in milk, such as chalk or starch, to give increased opacity to milk, is detected by the microscope.

Bread. "There is little adulteration of bread," says Wynter Blyth, "save with alum. The long and formidable list of substances supposed to be used by fraudulent bakers, such as sulphate of copper, peas, beans, &c., is drawn from rare instances, or from times of famine, or is based upon theory rather than observation. Bakers' bread in this country, taking it as a whole, is of fair purity and is wholesome. Where the customer is cheated is mainly in weight; here there are really serious and continuous frauds. Notwithstanding inspectors of weights and measures, such frauds are practically unchecked, and only limited by the prudential conscience of the baker." Blyth recommends a ready method of detecting alum in bread, which it will be well to give, as it is of very simple application. "The materials required for the test are a solution or tincture of logwood, to which a sufficient quantity of carbonate of ammonia has been added to render it strongly alkaline, and some slips of gelatin. A slice of the bread is then crumbled into a glass and covered with pure water, a slip of gelatin is added, and the whole allowed to stand overnight. In the morning the swollen and softened slip of gelatin is removed and stained with the ammoniacal logwood. If no alum is present, the gelatin will be of a dark pink or red colour; but if the bread contain alum, the gelatin will be coloured various shades of blue, from a barely-perceptible purple up to quite a decided blue, according to the quantity of alum present." The same solution of logwood simply painted over a piece of suspected bread will indicate by a blue colour if alum be present.

Flour, Arrow-root, Ground Rice, &c., are examined for adulteration by means of the microscope. The starch granules of all these substances are quite peculiar in form, and to one accustomed to the use of the microscope the detection of mixtures, &c., would be comparatively easy. Anyone who wished to examine flour, &c., of various kinds in this way ought first to provide himself with samples of the real article, whose purity was beyond doubt, for the purpose of comparison. He should have a sample of pure wheat starch (Fig. 249), pure potato starch (Fig. 250),

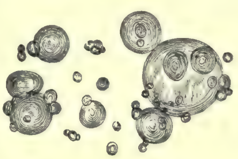


Fig. 249.—Starch Grain—Wheat.

pure Bermuda arrow-root, Canna arrow-root, tous-les-mois (Fig. 251), &c. The differences in the appearances of these different starches are considerable, as the figures show. But careful measurement of the size of the granules is also important, and this can readily be effected by microscopic methods; and finally polarized light is differently affected by different starch grains. A polariscopic apparatus for fitting to a microscope is easily obtained; and thus a complete examination can easily be conducted. By such means the adulteration of flour (Fig. 249) with cheaper potato starch (Fig. 250) is readily detected, and so on; and particles of foreign material, such as sulphate of lime, &c., can also be observed. The flour needs little preparation for examination. A few grains of it, or the arrow-root, or whatever kind of flour it be, are shaken up with a few drops of water in a small clean phial. A drop is placed on the centre of a glass slide and covered with a cover-glass, and then placed on the stage of the microscope. Glycerine is sometimes used instead of water, but it makes the starch granules too transparent.

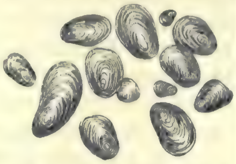


Fig. 250.—Potato Starch Granules.

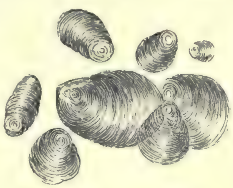


Fig. 251.—Tous-les-mois.

The three accompanying figures (252–254) show the starch grains of three different arrow-roots, the hilum (h) in Fig. 252 being slit-like or conical at the large end of the grain, but less distinct in St. Vincent arrow-root, and still less distinct in Port Natal arrow-root. These granules could not be confounded with wheat flour granules (Fig. 249), nor yet with the granules of potato starch. In the latter the hilum is at the small end of the grain, and the granules are much larger. The two following figures show the granules of bean flour and rice flour, sometimes used as adulterants of wheat flour.

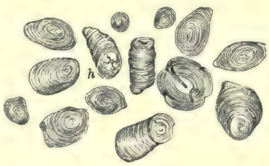


Fig. 252.—Bermuda Arrow-root.

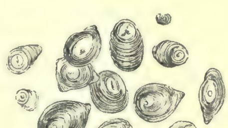


Fig. 253.—St. Vincent Arrow-root.

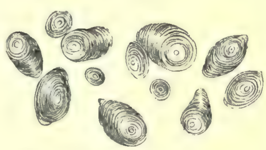


Fig. 254.—Port Natal Arrow-root.

Oatmeal is adulterated with barley-meal, and also with rice and maize; and these adulterations, which, according to Dr. Hassall, are very extensive, may be detected by means of the microscope.

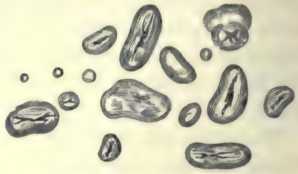


Fig. 255.—Starch Grain—Bean Flour.

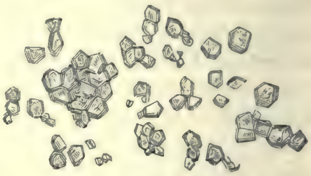


Fig. 256.—Starch Grain—Rice.

Unwholesome Meat.—Good meat, according to Dr. Letheby, possesses the following characters:—1. It is neither of a pale pink colour nor of a deep purple tint, for the former is a sign of disease, and the latter indicates that the animal has not been slaughtered, but has died with the blood in it, or has suffered from acute fever. 2. It has a marbled appearance, from the ramifications of little veins of fat among the muscles. 3. It should be firm and elastic to the touch, and should scarcely moisten the fingers, bad meat being wet, and sodden, and flabby, with the fat looking like jelly or wet parchment. 4. It should have little or no odour, and the odour should not be disagreeable, for diseased meat has a sickly, cadaverous smell, and sometimes a smell of physic. This is very discoverable when the meat is chopped up and drenched with warm water. 5. It should not shrink or waste much in cooking. 6. It should not run to water or become very wet on standing for a day or two, but should, on the contrary, be dry upon the surface. 7. When dried at a temperature of 212° or thereabouts, it should not lose more than 70–74 per cent of its weight, whereas bad meat will often lose as much as 80 per cent. It is also advised to pass a clean knife to the centre of the beef, and smell it after withdrawal, to ascertain if within also the beef is sound.

Very recent observations seem to show that cattle have been long an unsuspected source of disease communication to the people. At Hendon in England and at Glasgow epidemics of scarlet fever seemed undoubtedly to be due to the consumption of milk yielded by cows, suf-

fering from a disease presenting features akin to scarlet fever, as it attacks the human subject. The prevalence of tuberculosis in cattle, and the possibility of tuberculous cattle communicating the disease to human beings, through the medium of the meat of the slaughtered animals, sold for food, have recently occasioned profound anxiety and much discussion among veterinary surgeons. There are perfectly authentic instances on record of meat derived from diseased animals endangering human lives. At the same time there seems no doubt that cattle, which show signs of disease, are regularly slaughtered and sent into market, the owner preferring to do this rather than have the animals dying on his hands. In 1863 Professor Gamgee reported to the privy-council that as much as one-fifth of the common meat of the country was then derived from animals killed in a state of disease. It would, therefore, appear that many of these diseases do not render the meat unsafe for consumption, at any rate after it has been cooked. It is, however, quite possible that, to the eating of such meat is due many simple ailments or states of indisposition, which is not directly attributed to anything in particular. The outbreak of boils and some skin affections have been attributed to the flesh of animals killed when in an unhealthy condition. That there is, nevertheless, great danger in the use of meat obtained from animals suffering from disease of a contagious sort, has undoubtedly been proved. The purchaser has no reliable means of detecting such unwholesome meat. It is only by enlarged powers being given to local authorities, and to thorough and systematic methods of inspection, that this source of danger to the public can be checked.

The presence of parasites in meat, tape-worm of various kinds, and trichinæ, has been referred to at some length on p. 167 and subsequent pages. It is unnecessary to say more on that subject here, unless to call attention to the proof on p. 173 that thorough cooking destroys such parasites, and prevents meat containing them, which has been eaten in ignorance of their presence, from giving rise to any trouble.

Meat in a state of ordinary decomposition is also rightly regarded as unwholesome. Yet it is not nearly universally true that meat becoming decomposed, and even in advanced states of putridity, is hurtful. Game is preferred by the epicure when it is distinctly "high." The North American Indians prefer their meat well advanced in decomposition, and bury it underground to permit it gradually to become so. The Greenlanders treat seal flesh in the same way. Still, meat in a state of decomposition, even slight, is capable of giving rise in many people to severe irritation of the stomach and bowels, acting just like an irritant poison. Putrefaction it has been seen is a very complex process. It is the result of the activity of very many different organisms, each one attacking the meat to derive from it the particular nourishment it needs, and, in the process, producing by-products of peculiar kinds. What we call putrefaction is simply the changes evident to our senses that have been produced, but it is the combined result of many different organisms. It may be that of two pieces of meat, subject to putrefaction, one would be quite harmless, and the other hurtful, though in both the offensive smell, &c., seemed identical, because some particular organism had attacked the one piece and produced in it hurtful materials, not present in the other, whose presence, however, was not discernible by any alteration of odour. For the prevalent view regarding such organisms is that it is not so much the mere presence of the organism that is harmful, but the by-products of their activity. To some of these by-products of the decomposition of albuminous substances the term **ptomaines** has been applied by Professor Selmi of Bologna. It is a remarkable fact that in the course of digestion albuminous foods may yield products hurtful to the person. The fact that some persons cannot eat eggs, mutton, &c., is now partially explained by the view that they are peculiarly susceptible to the influence of certain substances formed during the normal digestion of these foods. The decomposition of fish has been shown to yield a poison, muscarine, which, before that discovery, was derivable only from one of the poisonous mushrooms—*Agaricus muscarius* (see p. 583). From the dead human body various poisons, more or less powerful, have been isolated. A considerable number of cases of sausage poisoning has been recorded, and there have also been several instances of marked symptoms of irritant poisoning after the use of tinned meats. These appear, without doubt, to be due to the presence in the meat of such ptomaines which have been developed as the result of decomposition of some of the albuminous constituents of the meat. It is quite unnecessary to suppose that any poisonous substance has gained entrance, by accident or design, to the meat. Moreover, there is no ordinary test by means of which one could be assured of the wholesomeness or otherwise of the food. The only pre-

caution one can take in buying tinned meats is to notice whether the surface of the tin is hollowed. If it is, one may be sure no decomposition has taken place within, which would be suggested if the tin were to bulge outwards.

Tinned Fruits and Vegetables are not infrequently contaminated by some adulterating agent, added to heighten the natural colour. Thus pickles, olives, green fruit, such as gooseberries, green-gages, and limes, as well as green vegetables, are adulterated with copper, the sulphate of copper, or blue-stone, being usually employed. The quantity of copper present per bottle is said to be as a rule half a grain per bottle. Red fruit—currants, raspberries, cherries—is heightened in colour by decoction of logwood, infusion of beet-root, as well as the red aniline colours. Dr. Hassall states that of 33 samples examined by him, only seven were free from contamination by copper.

To test for copper pour some of the fluid in which the fruit or vegetable is preserved into a tall glass vessel, add three drops of strong nitric acid. Immerse in the fluid for a few hours, a piece of thick, smooth and polished iron wire. If copper be present a fine coating of copper will appear on the wire. If the liquid used is vinegar, as in the case of pickles, it is not necessary to add the nitric acid.

THE DIGESTIBILITY OF FOOD.

In the preceding pages the value of food-stuffs has been considered from the chemical point of view mainly. We have seen that, for the nourishment of the body, substances containing nitrogen in the form of albuminous bodies, such as the white of egg, the casein or curd of milk, the myosin of flesh, the gluten of wheat, and the legumin of peas and beans, and carbon in the form of sugar, starch, and fat, are necessary, and that upon the quantities of such substances contained in the various food-stuffs does their nutritive value depend. But it is very necessary to consider foods from another point of view. These food-stuffs become valuable only when they have passed into and become part of the circulating blood in our bodies. This they cannot do in the condition in which we eat them, hence the elaborate apparatus and process of digestion, described in section VI. in the first part of this work, to fit them for entering and becoming part of the blood. This process requires time and implies the doing of work by the digestive organs—that is to say, the expenditure of energy. Now it is plain that if one substance takes a longer time and more work of the bodily organs to undergo digestion, more energy will have been expended in the process, and, before one could quite accurately judge of its value to the body as food, one would require to deduct from the total nutriment it was calculated to contain, a quantity representing the energy expended in its digestion. So that another substance, containing less nutritive material, might be actually more profitable to the body, because more easily and rapidly digested. The time, therefore, the various food-stuffs require in order to undergo digestion requires to be taken into account in estimating their relative values. In the next place one must consider how far each substance can yield up to the body the nutritive material which chemical analysis shows it to contain, whether it is in such a form, that is to say, as renders it suitable for the action of the digestive fluids rendering it fit to enter the circulation. If the nutritive material it contains cannot readily be extracted from it by the process of digestion, much of it will never really enter the body, but will simply pass through the alimentary canal unchanged, and be finally cast off as waste from the bowels. If the quantity of waste, so cast off after different diets, be measured, a fairly accurate idea of the actual amount of nourishment each diet has supplied to the body will be obtained. In determining the digestibility of foods, then, these two things require to be taken into account, the time required for their digestion, and the actual amount of each rendered available for purposes of nutrition. When these have been ascertained, and when this knowledge is added to that of the chemical composition of the various foods, one has the chief information necessary for the forming of a judgment as to the values of the different foods.

The Time required for Digestion of different substances is our first consideration. There are several ways of acquiring this information. As is indicated in section VI. Part I., the ferments, which are the active agents in digestion, can be separated out from the organs of the body in which they are prepared. The ptyalin of the saliva (p. 143), the pepsin of the stomach juice (p. 143), the pancreatin of the pancreas (p. 145), are readily obtained in quantity. One may take a solution of white of egg, a solution of boiled starch, and so on, place some in a test tube, add to it a small quantity of the digestive ferment, pepsin, pancreatin, &c., and then set it aside in a place kept at the temperature of the

body, and note what time elapses before the food-stuff has been completely acted upon by the ferment. Such experiments, made with different substances, under precisely similar conditions, will enable one to determine the relative speed of digestion of the different substances. A unique opportunity of observing the rapidity of digestion in the human subject, under ordinary conditions, was afforded to Dr. William Beaumont, in the person of one Alexis St. Martin, a Canadian, who had a permanent opening into the stomach through the skin, owing to a gunshot wound. Dr. Beaumont was able to introduce substances into the stomach through the opening and observe the rate of digestion. More recent experiments have been made in German laboratories, where students, laboratory attendants and others, willingly lent themselves for the purposes of observation, by taking food into an empty stomach, and, after varying times, allowing it to be withdrawn by a stomach-pump, so that the extent to which it had been acted upon might be determined. In various other ways much knowledge has been obtained.

The following list from Beaumont indicates the time of digestion *in the stomach* of various animal foods:—

Name of Food.	How Cooked.	Time.
Pigs' Feet (pickled), ...	Boiled ...	1 hour.
Tripe (pickled), ...	,, ...	1 ,,
Eggs (whipped), ...	Raw ...	1½ hours.
Salmon Trout (fresh), .	Boiled ...	1½ ,,
Barley Soup, ...	,, ...	1½ ,,
Venison Steak, ...	Broiled ...	1 hour 35 min.
Milk, ...	Boiled ...	2 hours.
Beef Liver, ...	Broiled ...	2 ,,
Eggs, ...	Raw ...	2 ,,
Cod (cured, dry), ...	Boiled ...	2 ,,
Milk, ...	Raw ...	2 ,, 15 min.
Turkey Eggs, ...	Boiled ...	2 ,, 25 ,,
Turkey, ...	Roasted ...	2 ,, 30 ,,
Sucking Pig, ...	,, ...	2 ,, 30 ,,
Lamb, ...	Broiled ...	2 ,, 30 ,,
Meat and Vegetable Hash, ...	Warmed ...	2 ,, 30 ,,
Chicken, ...	Fricassed ...	2 ,, 45 ,,
Custard, ...	Baked ...	2 ,, 45 ,,
Beef, ...	Boiled ...	2 ,, 45 ,,
Oysters, ...	Raw ...	2 ,, 55 ,,
Eggs, ...	Soft boiled.	3 ,,
Beef-steak, ...	Grilled ...	3 ,,
Mutton, ...	Boiled ...	3 ,,
Bean Soup, ...	,, ...	3 ,,
Chicken Soup, ...	,, ...	3 ,,
Oysters, ...	Roasted ...	3 ,, 15 min.
Pork Steak, ...	Grilled ...	3 ,, 15 ,,
Flounder, ...	Fried ...	3 ,, 30 ,,
Butter, ...	Melted ...	3 ,, 30 ,,
Cheese (old strong), ...	Raw ...	3 ,, 30 ,,
Mutton Soup, ...	Boiled ...	3 hours 30 min.
Eggs, ...	Hard boiled	3 ,, 30 ,,
Salmon (salted), ...	Boiled ...	4 ,,
Fowls, ...	,, ...	4 ,,
Soup, Beef, Vegetables, and Bread,	,, ...	4 ,,
Heart, ...	Fried ...	4 ,,
Marrow Bone Soup, ...	Boiled ...	4 ,, 15 min.
Pork (recently salted),	,, ...	4 ,, 30 ,,
Veal, ...	Fried ...	4 ,, 30 ,,
Wild Duck, ...	Roasted ...	4 ,, 30 ,,
Mutton Suet, ...	Boiled ...	4 ,, 30 ,,
Pork, ...	Roasted ...	5 ,, 15 ,,
Beef Suet, ...	Boiled ...	5 ,, 30 ,,

The time of digestion of vegetable foods is shown in the next table:—

Name of Food.	How Cooked.	Time.
Rice, ...	Boiled ...	1 hour.
Apples (sweet mellow),	Raw ...	1 ,, 30 min.
Sago, ...	Boiled ...	1 ,, 45 ,,
Tapioca, ...	,, ...	2 hours.
Barley, ...	,, ...	2 ,,
Apples (sour), ...	Raw ...	2 ,,
Pod Beans, ...	Boiled ...	2 ,, 30 min.
Parsnips, ...	,, ...	2 ,, 30 ,,
Potatoes (Irish), ...	Roasted ...	2 ,, 30 ,,
Cabbage (head), ...	Raw ...	2 ,, 30 ,,
Apple Dumpling, ...	Boiled ...	3 ,,
Corn Cake, ...	Baked ...	3 ,,
Corn Bread, ...	,, ...	3 ,, 15 min.
Carrots, ...	Boiled ...	3 ,, 15 ,,
Bread (wheat, fresh), .	Baked ...	3 ,, 30 ,,
Turnips, ...	Boiled ...	3 ,, 30 ,,
Potatoes (Irish), ...	,, ...	3 ,, 30 ,,
Green Corn and Beans,	,, ...	3 ,, 45 ,,
Beets, ...	,, ...	3 ,, 45 ,,
Cabbage, ...	,, ...	4 ,,

The times given in these tables are the mean times in the case of the particular individual experimented on, and are not to be taken as absolute, though they fairly indicate the relative digestibility in time of the different substances. In the case of that one individual the time required for digesting the same substances varied on different days with varying conditions of the person himself, and with varying external conditions also. Thus the rapidity varied with the quantity eaten. A full meal was digested even more readily than a small and insufficient one, though, as one would expect, excess of food slowed the process. The rapidity varied also with the nature and amount of previous exercise, and with the interval since the preceding meal. After prolonged and exhaustive exercise the digestive organs share in the general depression, and food ought not to be immediately taken; while, if too short an interval has elapsed since the last meal, the next one finds the stomach unprepared to receive it. In the

case of St. Martin the state of the weather was found to affect the rapidity of digestion. Active exercise immediately *after* a full meal tends also seriously to interfere with the digestive process, and even to arrest it. If the meal has been small, moderate exercise facilitates its digestion, and moderate exercise is also of advantage some time, an hour or so, after a full meal.

Somewhat conflicting views are held as to the influence of sleep after a meal, many maintaining that the after-dinner nap, customary with many people, interferes with the rapidity of digestion. It is unwise to lay down hard and fast rules. It is an undoubted fact that a sleep after dinner is useful to many, though it may be injurious to others. It may be said with some confidence that a sound and prolonged sleep is hurtful, because in sleep the activity of the vital processes is diminished, and this, lasting for any time, would undoubtedly retard digestion. It may be taken as a general rule that after a full meal, such as dinner, it is better to pass an hour or more in pleasant conversation, or some similarly light occupation, before any active work is engaged in. After lighter meals, such as lunch, tea, &c., no such interval is required.

Dr. Beaumont found that cold drinks introduced into the stomach in any quantity during digestion had a markedly slowing influence upon the process. A single gill of water at 50°, introduced on one occasion, lowered the temperature within the stomach to 30°, and its natural heat was not restored for half an hour. Drinking iced water, or cold fluids in any quantity, eating of ices after meals, &c., are therefore not to be encouraged.

One extremely important factor in the rapidity of digestion of solid food is the degree to which it has been broken down by chewing. If the food be imperfectly chewed, it remains in large pieces, and the gastric juice cannot penetrate to the interior of the masses; whereas if the food has been broken up into minute portions, they are all attacked at once, and digestion is rapidly completed. Probably this supplies the reason of the greater rapidity of digestion of boiled over unboiled milk. In the process of digestion milk curdles, the curd forming masses of considerable size, which take some time before they are broken down by the gastric juice. If the milk has been boiled, the curd formed is in much smaller masses, and hence the greater ease in digestion.

As regards the actual time taken by some of the substances, the above table will occasion some surprise by the length of time assigned to soup for its digestion. Barley soup digested in 1½ hours, but bean soup and chicken soup took as long, 3 hours, as grilled beef-steak and boiled mutton, while mutton soup took half an hour more, and bone soup 1¼ hours longer. Contrary to one's expectation soups and fluid diet are not more easily digested than solid nutriment. This is confirmed by the experience of invalids, convalescents, and dyspeptic persons, who very frequently prefer a solid or semi-solid diet to the beef-teas and chicken broths which are the popular diets for them. Dr. Beaumont says that "solid food is sooner disposed of by the stomach than fluid, and its nutritive principles are sooner carried into the circulation." It has been observed, however, that the exhaustion from abstinence is more quickly removed by liquid than by solid nourishment. On the whole animal food, when suitably cooked, is more easily digested than vegetable food, in particular than green vegetables.

The Influence of Cooking on the Rapidity of Digestion is well shown in the tables that have been given.

Raw whipped Eggs digested in		1½ hours.		
Raw Eggs (ordinary)	,,	2	,,	
Soft boiled Eggs	,,	3	,,	
Hard ,,	,,	3	,,	30 min.

The whipped eggs were digested most readily, because by the whipping process the egg was worked up into a froth, that is, the egg was separated up into minute particles by the switching in of air, and the digestive fluids attacked it most easily. The heating process coagulates or clots the chief constituent of the egg, and renders it no longer soluble in water. The longer it is boiled the more insoluble it becomes, and the longer is its period of digestion. This is worthy of noting, because a similar change is produced in the albuminous substances of butchers' meat by cooking. If the meat is subject for any length of time to a heat as great as that of boiling water, all its albuminous material becomes changed into the insoluble form, and its readiness of digestion is consequently much diminished. This is very well shown in the case of experiments performed by Jessen, at Tübingen. The subject of the experiments was a laboratory attendant. He took meat, raw or cooked in various ways, and after the lapse of varying times allowed it to be withdrawn by means of a stomach pump to determine the rapidity of digestion. The different kinds of

meat were all taken on an empty stomach, so that no disturbance could arise by the presence of other foods. In this case the following were the results:—

Raw Beef digested in	... ...	2 hours.
Boiled Beef (half done) digested in		2½ ,,
Boiled Beef (well done)	,,	3 ,,
Roasted Beef (half done)	,,	3 ,,
Roasted Beef (well done)	,,	4 ,,
Raw Mutton digested in	...	2 ,,
Raw Veal	,, ...	2½ ,,
Raw Pork	,, ...	3 ,,

This shows that the more thoroughly meat is cooked, the longer is the time required for its digestion. Raw or half-raw meat is therefore preferable to well done meat. But then there arises the risk of being supplied with meat containing the eggs of intestinal worms (see p. 167), which thorough cooking would render harmless (see p. 173). Vegetable foods, however, require cooking for their digestion, and thorough cooking. The cellulose, which envelops starch grains and invests vegetable cells, is not soluble in the digestive fluids. By the process of cooking it is ruptured, and the contents of the cellulose envelope are therefore allowed to come into contact with the digestive juices.

Aids to Digestion in the shape of condiments, mustard, pepper, and alcoholic stimulants are much in use for accelerating the digestive process. Experimental physiology offers a few results in the direction of justifying an opinion on this subject also. It appears from sundry experiments that, in health, these adjuncts are not necessary. In one or two of the trials all flavouring materials were removed from the food before it was given. It was thus rendered tasteless and insipid, and was eaten without relish, indeed with distaste and almost repugnance, by the person, and yet its digestion was not impeded. In the case of the healthy, therefore, only the milder kinds of flavourers or appetizers ought to be used. On the other hand, in the case of those of small appetite or feeble digestion, there is no doubt such appetizers are valuable, not only because of the fillip which they give to the appetite, but also because, by their stimulating action on the mucous membrane of the alimentary canal, they excite increased flow of blood to the part, and increased secretion of digestive juices, with consequent increase of the digestive capacity. But the risk of healthy persons, who need no such goads to digestive activity, employing such agents, from liking, to excess, ought to be guarded against. If the stomach is accustomed to pronounced exciting to its work, by and by it will refuse to act till the stimulus is applied.

The Influence of Tea, Coffee, Whisky, &c., on the Time of Digestion has recently been studied by Sir Wm. Roberts of Manchester. He carried out his observations by means of test-tubes containing, some of them solutions of starch, others of them morsels of beef, &c. To these he added the digestive ferment, and observed how long the process occupied in the test-tube, kept at a proper temperature. To a test-tube with exactly the same ingredients, he added a definite quantity of infusion of tea, or coffee, or whisky, &c., as the case might be, and contrasted the rapidity in this case with that of the preceding.

In the case of the digestion of starch he found that a 5-per-cent infusion of tea arrested starch digestion when it amounted to 10 °/₀ of the total contents of the test-tube. That is tc say, if the contents of the test-tube consisted of tea infusion to the extent of a tenth, digestion stopped. Even if the tea infusion was only a hundredth part of the contents of the test-tube, the digestion of the starch was slowed. *This injurious effect of tea, Roberts found, was prevented if* 10 *grains of bicarbonate of soda* (*the quantity that can be taken up on a threepenny piece*) *were added to each* 10 *ounces* (*that is half a pint, or a breakfast-cupful*) *of tea.* Coffee had not the same effect to the same extent, for double the quantity of a 5-per-cent infusion of coffee did not affect the action on the starch to the same extent.

The digestion of starch was slowed by 10 per cent, and quite stopped by 20 per cent of French brandy, while it took twice the quantity of Scotch whisky to produce the same effect. This action was due not to the spirit, but to the ethers and volatile oils contained in the brandy and whisky, and more in the former than the latter. In the case of wine 1 per cent was sufficient to arrest digestion, because of the acidity of the wine. If to sherry or port something be added to counteract the acidity, such as effervescing soda, potash, or seltzer water, or Apollinaris, the slowing action is prevented. Simple aerated water will not do: it must contain some alkali, like soda or potash, in solution.

Roberts extended his experiments to digestion as carried on in the stomach, and found similar results. Tea and coffee both seriously delay digestion there, and so also does cocoa, though not to the same extent as either of the former. Twenty per cent of a 5-per-cent infusion of either tea or coffee seriously slowed

the process, while a quantity equal to ten per cent had a perceptible effect.

In the case of alcoholic liquors it was found that, if the total amount added to the food was not sufficient to make the quantity of proof spirit more than equal to a tenth of the total bulk of the food, no retarding effect was observed; when the quantity reached 20 per cent—was a fifth, that is to say, of the total bulk of the food—the slowing effect was slight; and when it reached 40 per cent almost no digestion occurred. Roberts estimated that if the total quantity of food taken into the stomach at a meal weighed 2 lbs., then 2 ounces of brandy or whisky—that is, less than a wine-glassful—would equal five per cent, and would not impede digestion. But if the quantity of spirit were increased, the delay of digestion would set in, in proportion to the quantity of alcohol above the 2 ounces taken. Sherry slows digestion to an extent out of all proportion to the spirit it contains, a quantity equal to a fifth of the total bulk of food taken making the time needful for digestion three times longer than it ought to be; while double that quantity altogether stopped it. Sparkling wines were less injurious than still wines. Malt liquors also impede the process, and, like wines, to an extent quite out of proportion to the contained spirit. When the malt liquor reached to 40 per cent of the bulk of the food, the deterrent action was very marked. If, then, malt liquors, such as stout, are taken with dinner for the sake of their stimulating effects, specially in the case of invalids, a much smaller quantity than the customary pint bottle yields should be used. It will very frequently be found that a third of that amount is useful without impeding digestion. Hence the value of the ½-pint bottles now coming into use for the various kinds of nourishing or "invalid stout," as it is called.

The Quantity of each Food-stuff extracted in the body for purposes of nutrition must next be considered. This is determined by weighing the quantity of food eaten, and then weighing the waste cast off from the bowel. The difference represents the amount of food retained in the body for use. Though two foods contain the same amount of nutritive materials, but one of them invariably yields more waste, it is evident that that one is of less value; it is, that is to say, less digestible. A considerable number of experiments has been made in this direction, chiefly in German laboratories; and the results are summarized in the following table. In each case the calculation is made for 100 parts of the food-stuff, and in one column is shown the proportion of that retained in the body, and in the other the proportion expelled as waste.

Name of Food.	Proportion Used in Body.	Quantity Expelled.
Sugar, ...	100	0
Butter, ...	98	2
Oleo-margarin, ...	96	4
Rice, ...	96	4
Fish, ...	95·1	4·9
Maccaroni, ...	95·7	4·3
Roast Beef, ...	94·8	5·2
Hard-boiled Eggs, ...	94·8	5·2
White Bread, ...	94·4	5·6
Milk and Cheese (in proportions of 11 of former to 1 of latter), ...	94	6
Indian Corn, ...	93·3	6·7
Milk and Cheese (9½ to 1), ...	93·2	6·8
Cow's Milk, ...	91	9
Pease Meal, ...	90·9	9·1
Potatoes, ...	90·6	9·4
Rye Bread, ...	89·9	10·1
Milk and Cheese (2 to 1), ...	88·7	11·3
Cabbage, ...	85·1	14·9
Coarse black Rye Bread, ...	85	15
Carrots, ...	79·3	20·7

Putting sugar and butter aside as being used only as adjuncts to food, we find that rice, meat, and eggs (and fish is included with meat) head the list of digestible articles, practically yielding up almost all the nutriment they contain to the body. Of bread it is interesting to note that the quantity of nutriment extracted depends on the fineness of the flour. Thus rye bread is far behind white bread, and the coarse black bread still further. We have here an illustration of the fact commented on on p. 560, that though the branny portions of the wheat-grain contain more tissue-forming material than the white kernel, their addition to the flour to any extent does not make the bread more valuable, both because these coarser particles are less digestible and because they so stimulate the bowel as to hurry the material too fast along the alimentary canal. As regards milk it is very interesting to observe that there is less waste on an exclusively milk diet in the case of the infant than in the case of the adult. Thus in the case of a child, observed for 11 days, 6·35 per cent of the dry solids of the milk were expelled daily from the bowel, while in the case of the adult the amount varied from 7·8 per cent to 10·2 per cent. This is another proof of what has already been said on p. 542, that as an exclusive diet milk is more suited for the growing than for the full-grown person. In the adult a considerable proportion of the waste consists of the mineral constituents of the milk, particularly the lime

salts, which the child retains for the formation of bone. In short, cow's milk is not so advantageous a diet for the adult as meat or egg. The experiments made with milk and cheese were so performed because cheese could not be made an exclusive diet. It may seem remarkable that milk with a small proportion of cheese should be more completely made use of than milk alone. The reason seems to be that milk alone forms large masses of curd in the stomach, in process of digestion, which the gastric juice cannot quickly attack, while, if cheese has been eaten, the small particles prevent the curd forming in such masses, and permit of the gastric juice attacking a large number of smaller portions of curd at the same time. If the proportion of cheese rises unduly, then it is not so completely digested. Then it is to be noted how much more digestible the animal foods are than those vegetable foods which are rich in proteids or tissue-forming materials, such as peas, beans, &c. If animal food is to be entirely replaced by vegetable food, it must be by such foods as peas, beans, and lentils, for these only contain a rich supply of the needful proteid. The table shows that such replacement would not be economical of the energy of the body. As regards fat, though the table is silent on that point, it appears that animal fat is more digestible than vegetable fat, and more easily assimilated.

Such considerations do not countenance the use of vegetable foods to the exclusion of animal foods. They rather support the view that an appropriate mixture of the two kinds of food-stuffs will most readily yield the desired quantity of nutriment to the body, with the greatest economy of bodily energy, and corroborate the position taken up in the early part of this section, that, for growth and repair of tissues, material is most readily and abundantly yielded by animal foods, and for yielding of energy for the maintenance of heat and the doing of work the material is most easily obtained from the vegetable kingdom.

THE PRINCIPLES OF COOKING.

Why do we cook? is a question which would probably puzzle a great many people who pride themselves on their skill in the art of cookery, but it is a question on which really depends the answer to the other question, *How* should we cook? Probably, in the first instance, the object of cookery is to please the palate, so that eating shall not be simply a necessity of continued existence, but also an ever-recurring source of pleasure and gratification. But a second and very important object in cooking is to render the food to be eaten more readily digestible. The immediate purpose of eating is to satisfy the demand for material for the upkeep of bodily strength and vigour, and it is evident that the success of cookery and its methods are to be judged by the extent to which it aids that purpose and adds pleasure to it, while any method is self-condemned which renders the task of extracting the nutriment from the food more difficult for the body, even though it, at the same time, adds greater pleasure to the taste. These two main objects of cooking are of very great importance for all classes of the population. There is far too great a tendency to regard what is called, with some suspicion of a sneer, the "gratification of the palate" as an object which can only be followed by the moderately "well-to-do people," and as a consideration which the poorer of the community cannot afford to regard. As an absolute matter of fact it is a subject of more importance to those of limited means than to those of large resources. It has been shown that the flavour of a meal has not any influence on its digestion in the case of a healthy man. But the same experiments which proved this proved also that the absence of flavour was a serious hindrance to the taking of a proper quantity of food. Thus Prof. Forster observes that in the case of one man, on whom he experimented, meat from which the flavour had been removed was so tasteless as to be eaten in any considerable quantity only with difficulty, and yet the quantity digested and passed into the circulation was as large as with the same meat roasted in the ordinary way; and in other experiments with a mixed diet, from which also the flavour was removed, the diet became, when continued, so repugnant that great effort was required to eat it, while, nevertheless, the digestion was unaffected. Now in the case of those with limited means the diet is apt to be, indeed is certain to be, much more restricted in variety, and its sameness will in time produce something of the same aversion. In such cases the art of cookery has greater scope, and becomes of infinite value by the variety it may introduce without additional expense, and its benefits will be far more marked than in the case of those whose means permit of a greater variety of food-stuffs. The poorer classes have, indeed, more need of knowledge being put within their reach of the method of gratifying the palate by the art of

cooking than the richer classes. There can be little doubt that the temptation among the working-classes to the frequent use of stimulants is greatly strengthened by the lack of variety and excitement in the food habitually served up to them, and that the introduction among them of better and more extensive methods of cooking would have a direct and powerful effect in the promotion of temperance. It would also add to their material resources by showing them how simple and inexpensive articles, remnants of former meals, and so on, might be dressed up in agreeable and appetizing and satisfying forms. For it has been shown by actual statistics that there is no class of the population which buys so expensive kinds of food—the richest cuts of beef, for example—all to obtain the richness and strength, which they think is associated with the fuller flavour, and which they might confer on the food more cheaply by modes of preparation.

Cooking has very different effects on animal food from those it produces on vegetable food. It has been shown in the preceding article that, as a rule, animal food is considerably more digestible in the raw than in the prepared state, while the chief vegetable foods, such as bread, oatmeal, rice, corn-flour, green vegetables, &c., are made digestible only by sufficient cooking. On the other hand the flavour of both is largely the result of the method of preparation. In the case of animal foods, in particular, the question thus comes to be, How may it be cooked so as to develop its finest flavour, without unduly diminishing its digestibility?

Let us take, as an example, a piece of beef or mutton. The nutritive material it contains is chiefly the proteid or albuminous constituent, which forms the chief part of the red flesh. This is largely soluble in cold water, and is in that form easily digested. But by water near to the boiling point, or by heat to the same degree, however applied, it is coagulated and rendered insoluble and less easily digested, and the greater the heat and the longer it is applied the more solid becomes the coagulated mass, and the more difficult does it become of digestion. The connective tissues or fibrous portions which bind the red flesh together, and also form the tendinous parts, are converted into gelatine by boiling, and are rendered more easily broken down, so that the mass of meat can be more easily broken down into particles, can be more easily chewed, and therefore more readily prepared for the action of the digestive juices. To this extent, therefore, cooking will aid the digestion of animal food. The flavouring materials, the extractives of the meat, are dissolved by water, and in process of cooking with water may readily be dissolved out to a large extent, rendering the meat more or less tasteless. Moreover the action of the heat develops flavouring substances in the meat not existing in it previously as such. The nature and extent of these sapid substances entirely depend upon the manner in which the heat is applied. They are specially developed by a dry heat, as applied in roasting, and it is owing to their production that roast beef is so much more full in flavour than beef cooked otherwise. It appears, then, that the cooking of a leg of mutton is a much more complicated problem than many people suppose. For the desire is (1) to apply the heat long enough to heat it equally throughout, and to render it as tender and easily masticated as possible, (2) to guard against extracting from it any of the flavouring materials it already possesses, (3) to develop as much as possible new flavouring substances, and withal (4) to avoid so great a degree of heat, or so long continued an application, as would harden the flesh and render it difficult of digestion. These are the different points to secure which a cook really aims, when a leg of mutton or a roast of beef is set him to prepare, whether he would express them in so many words or not, and they clearly indicate a particular method to be adopted.

But now suppose the same cook has a piece of beef or mutton set before him for the making of soup. His object is now very different; it is no longer to retain in the meat as much of its flavouring materials and juices as possible, but to extract them, and to get as much of them as he can into the surrounding water; and his method must be correspondingly different. If one clearly realizes to one's self the difference between these two processes, and the difference of method they imply, then one shall have laid a sure foundation for the practice of cookery; but every one who has not realized them is ignorant of the very A B C of the science. Let us consider the two cases.

To extract the juices of meat is easy enough, unfortunately too easy, many people will say, and too often done. All one requires to do is to steep the beef in cold water, and, particularly if it has been broken down into small pieces, all of its flavouring material and a considerable quantity of its nourishing material will become dissolved in the water. But how to retain the juices in the meat is the problem. Suppose the leg of mutton to be plunged into boiling water,

what will happen? Almost immediately the albuminous portions of the meat in contact with the boiling water will become insoluble, will coagulate, and if the meat be exposed to this heat for a short time only, it will have become completely surrounded by a film of coagulated material, the heat not having had time to penetrate far in—will have become sealed up as it were; and if the mutton were now placed in cold water, this coagulated film, being insoluble, would oppose the passage outwards of the juices of the meat. If the meat were kept in the boiling water the heat would gradually penetrate inwards, coagulating and hardening as it proceeded, the outer parts becoming always harder and drier because of the prolonged action of the high temperature. But if, after the meat has been two or three minutes in the boiling water, the heat of the water is allowed to fall considerably, then a film of coagulated albumin will have formed outside sufficient to retain the juices of the meat, and the cooking can be proceeded with at a lower temperature and a longer period without risk to juiciness and tenderness. Exactly the same principles are applicable in roasting or baking meat. One desires to cook the meat throughout to a certain degree, but to retain all the juice within it. If it is exposed suddenly, and all round, to the full influence of a bright clear fire, a film of coagulated albumin is formed, sealing up the juices; then the meat is withdrawn from its close proximity to the fire, or if it be in an oven the heat of the oven is allowed to fall, and cooking gradually proceeded with.

Boiling, roasting, baking, broiling and frying are the chief ordinary operations in the preparation of food, and these may now be briefly noticed in detail.

Boiling. What has been already said in general is specially applicable to boiling. In boiling the heat is communicated to the meat by the agency of water, and, except in the production of soups and beef-teas, and the like, one desires to convey as little as possible of the material of the meat to the medium of communicating the heat. To cook meat by this means, therefore, which is to be served up at table, the water should be boiling, the meat plunged into it, there being sufficient water completely to cover the meat, and the pot should be kept on the fire till the water again boils. The introduction of the meat will have put it "off the boil" for a few minutes. When the water has boiled again for two or three minutes, not more, the pot should be removed to the side of the fire, so that the temperature of the water is reduced to below even the simmering point. If one were to gauge the temperature by means of a thermometer, it would be not more than 180° Fahr., or between that and 160° Fahr. (boiling point is 212°). At this heat it should be kept till the central parts of the meat have had time to be heated to the same degree. The time necessary will depend, of course, on the size of the piece of meat, and it will be longer than if the boiling temperature were maintained; but the reward of the longer period is juicy meat, tender, and with its fibres soft and readily separated from one another, not firm, tough, and shrunken. In thus cooking meat a fork should never be plunged into it to see if it is sufficiently done, for this would break the sealing and open a way of escape for the retained juices. Meat when thus properly cooked is easily recognized at table by the rush of juice as soon as it is cut.

Fish should always be boiled in this way, with skin as unbroken as possible; and their flavour is still better obtained if the water used is hard, if sea-water is used, or if some salt is added to fresh water.

In the case of eggs the same method produces excellent results. They are commonly kept in boiling water for three minutes or so. The white becomes exceedingly firm and indigestible, specially next the shell, and often the yolk is unaffected. Now if the eggs be plunged into boiling water and immediately removed from the fire altogether, but allowed to remain covered up in the water for ten minutes, the white will not be hardened, but nicely jellied, and the yolk just set. This is the condition in which eggs should be eaten. This is called "coddling eggs;" and while it may be done in a small covered pan, it may also be done on the breakfast table by means of an appropriate vessel. A tin vessel is obtained so deep that when half full of water an egg would be completely immersed. It may be made of any diameter one pleases, according to the number of eggs one may have to cook in it. It should have a tight-fitting lid, and should be embedded in a "cosy" made for it. A cover should also be made for the lid, so that the whole vessel is surrounded by a cosy. The boiling water is poured into the pan, $\frac{1}{2}$ pint for 1 egg, $\frac{3}{4}$ths of a pint for 2 eggs, and 1 pint for 3 eggs, and the eggs immediately placed in the water, the lid secured, and the whole covered up. This can lie on the table, and the water and eggs are introduced 10 minutes before the breakfast is served. If a few minutes' delay

occurs the eggs are not overdone, and they are kept hot for a long time.

For the production of broth, and when it is desirable to extract all the possible ingredients of the meat, a high temperature is not necessary at any time. The meat should be reduced to small pieces, placed in cold water for some time, slowly heated, but never to the boiling point, for even before that high temperature is reached the albuminous constituents which have become extracted will be coagulated and separated out, but will remain in solution if a lower temperature is maintained. When it is desired to produce stock from tendinous meat, such as hough or joints of bone, prolonged boiling is necessary for the extraction of gelatine, which is derived from tendons, gristle, &c., by boiling.

The flesh of young animals, veal and lamb, does not stand boiling well, because of the large amount of gelatine-yielding substance present, the dissolving out of which makes the meat fall to pieces.

Boiling is the method of preparation most suitable for invalids and those of weak digestion, but it develops the flavour of meat much less than either roasting or stewing, and is not so much enjoyed. Boiled meat is more easy of digestion than that cooked in any other way (see p. 603).

Roasting has already been referred to. The meat ought at first to be brought close to a bright clear fire till the surface is coagulated to retain the juices, then it ought to be withdrawn to such a distance that the heat can never rise above 180°, and it is then allowed gradually to cook throughout. The dry heat causes a considerable loss by evaporation of water, and, to prevent this going on unduly, basting is resorted to by the use of melted butter or the dripping caught in the pan. Not only does this prevent drying but it aids the browning of the outside of the meat, and it is by this browning that the peculiarly acceptable flavour of roast meat is produced.

While roast meat is not so digestible as boiled, it is more acceptable as a rule, because of the increased flavour, and next to boiling, it is most suitable for invalids and dyspeptics. The fat of the meat undergoes some amount of chemical change because of the prolonged action of the heat, and fatty acids are produced which are the chief cause of some tendency to disagree with persons of weak digestion.

Broiling or **Grilling** is practically the same as roasting in its effects. The cooking on the grill is done with great rapidity, a hot clear fire being necessary. The grill being brought close to the fire at first and rapidly turned, the whole surface of the meat is sealed. The grill is then removed to a little distance, and the interior portion of the meat is done more slowly, being cooked in its own juices, as it were, within the outer crust that has been formed. This is an excellent method, when well done, for cooking a chop or steak, and produces a very savoury dish, little less digestible than by boiling.

Baking is pretty much the same as roasting, but being done in the confined space of the oven, partly by hot air, there is less of the material of the meat driven off as vapour in the process. Consequently the flavour produced is much richer and fuller than in roasting. On that account baked meats are much less digestible than roasted, and had better be avoided altogether by the dyspeptic.

Frying is an excellent but much-abused method of cooking. The common method of frying is by the use of the ordinary shallow frying-pan, and the meat is kept from sticking to the pan and burning by some melted butter, lard, or dripping. Now this suits well enough for meat cut in very thin slices such as ham, which can be kept fairly well covered with the liquid fat, or for eggs or omelettes, but is entirely unsuited for other kinds of meat. What is properly meant by frying is cooking in oil, in which the oil is made the vehicle for communicating the heat to the meat, just as water is the vehicle in the case of boiling. This requires a deeper vessel than the ordinary frying-pan, capable of holding such a quantity of fat as will permit of the meat being completely immersed. Now fat boils at a temperature very much higher than water, indeed cannot be boiled in an open pan at all, so that long before its boiling point is reached the temperature of the liquid fat is far above the highest temperature obtainable with water, namely, 212°. Lard is commonly used, and when it is put into the pan and kept on the fire for some time the liquid fat bubbles and crackles as if it were boiling. By and by it becomes quiet. It has not been boiling: it has reached the temperature of boiling water, and then any water contained in the fat is driven off as steam, causing the commotion. When all the water has been evaporated the surface of the liquid becomes still, and the temperature of the fat is then considerably above 212°. Its temperature continues to rise, and soon if bread crumbs be dropped into the fat they at once become browned. At this stage

the meat may be introduced. The cutlet or chop is usually covered first with a coating or batter of switched eggs and bread crumbs, and then dropped into the oil, so as to be completely covered by it. If the fat is sufficiently hot the chop or cutlet is cooked in about 10 minutes, very equally throughout, and the coating has acquired a delicate brown with a crisp feeling and pleasant flavour. The hot oil in contact with the outside of the meat has coagulated the albumin, the continuance of the heat has raised the interior of the meat to the boiling point, and it is cooked by the heat of its own juice. Above the boiling point the heat of the meat cannot rise so long as it contains any juice, and the juices are retained. The result is that if the time be properly gauged the meat is well cooked, juicy and tender. The spitting and hissing noise produced when the meat is introduced is due to the explosion of little globules of steam, produced by contact with the hot oil. Further, owing to the very heat the oil is prevented passing into the meat, and when it has been removed and the surface oil allowed to run off, no trace of fat is left. Now this is not an expensive method of cooking, for there is actually less fat used than with the ordinary frying-pan. The fat is readily purified for use again by pouring it, still hot, into a vessel of water. The impurities sink into the water; the fat floating, is easily removed when cold. Besides pure lard, cotton-seed oil (p. 591) may be used. It is, when obtained pure, an excellent oil for the purpose, of very agreeable and delicate flavour, and has the advantage of being much cheaper than lard. This is the only proper method of frying; and when chops, cutlets, and fish are so cooked they are not only pleasant in flavour but also not difficult of digestion. The ordinary shallow frying-pan, on the other hand, is destructive to the meat cooked in it. The meat is really dried, hardened, and shrivelled, and its digestibility very seriously impaired. The use of such a pan ought to be limited to the cooking of omelettes, pancakes, and such like.

Stewing is a process whose object is entirely different from that of the methods already described. Little or no water is added to the meat in the stew-pan. *The meat is never raised to the boiling temperature.* The juice of the meat is thus allowed to exude, and additional liquid is obtained from the various herbs, vegetables, &c., mixed with the meat. A rich full-flavoured gravy is thus obtained in which the meat becomes cooked. Now in the ordinary stew-pan the difficulty of keeping the heat at a proper level is very great, because the meat is directly in contact with the vessel on the fire. As a result a boiling, or, what is next to it, a simmering temperature, is communicated to the meat, which is thus toughened and shrunken by the firm coagulation of its albuminous constituents. If, however, the stew is kept at the proper temperature, about 180° Fahr.—not even a simmering heat—this does not occur, the meat is tender and juicy and easy of digestion. This is easily secured by a vessel called the *Bain Marie.* It is constructed on the same principle as an ordinary glue-pot. One vessel is fitted inside an outer one. The outer one contains water, which thus surrounds the inner. The vessel is put on the fire, and the meat, vegetables, &c., in the inner vessel, the whole being covered by a lid. The water in the outer vessel comes to the boiling point, but any liquid in the inner one never reaches such a degree because of the loss of heat by evaporation. The water in the outer vessel would require to be raised above the boiling point, which cannot happen, before that in the inner could reach that point. This is the method employed by the continental peasantry, whose stews are famous for their tenderness and delicacy. "The poor peasant, with her 2 or 3 ounces of meat for a large family, puts it into a *pot au feu,* along with what vegetables she happens to have, puts it in after breakfast and leaves it there; it never gets up to boiling point; the meat and vegetables are intermingled, and a nice dinner is obtained for about one-third of what it costs our people of the same class for a lump of salt bacon." Again, the poor French peasant, says Mattieu Williams, does more with one pound of meat, in the way of stewing, than the English cook with three or four. "The little bit of meat and the large supply of vegetables are placed in a pot, and this in another vessel containing water—the *Bain Marie.* This stands on the embers of a poor little wood fire, and is left there till dinner-time, under conditions that render boiling impossible, and demand little or no further attention from the cook. Consequently the meat, when removed, has parted with its juices to the *potage,* but is not curled up by the contraction of the hardened albumen, nor reduced to stringy fibres. It is tender, eatable and enjoyable." Count Rumford says: "In many countries where soups constitute the principal part of the food of the inhabitants, the process of cooking lasts from one meal-time to another, and is performed almost without

either trouble or expense. As soon as the soup is served up, the ingredients for the next meal are put into the pot (which is never suffered to cool and does not require scouring); and this pot—which is of cast-iron or earthenware—being well closed with its thick wooden cover, is placed by the side of the fire, where its contents are kept simmering for many hours."

Vegetable food, unlike animal food, can scarcely be too thoroughly cooked, and boiling is for all the most suitable process. Starchy vegetables such as potatoes are not digestible unless they have been boiled sufficiently to cause all the starch-grains to swell and burst their cellulose envelopes. It is this that causes the potato to become mealy by cooling. Sodden and hard or waxy, they are not digestible. Potatoes should be placed in boiling water, with the addition of salt. There is no doubt that boiled potatoes in their skins retain a flavour, of which they are otherwise robbed. The skins of the potatoes do contain some small percentage of a poisonous alkaloid, solanine, which is extracted by boiling and probably destroyed. There is, therefore, some reason for the refusal to use the water in which potatoes have been boiled in their skins; but there is no reason for the throwing away of the water in which peeled potatoes have been boiled, since the alkaloid has been removed in the peelings. Steaming is, however, the most excellent method for the cooking of potatoes, no element of flavour being thereby lost.

Green vegetables require prolonged boiling to make them tender. They should be placed in boiling water, and kept boiling uninterruptedly till removed for being served. As green vegetables are specially valuable for the salts they contain, and as these salts are to a considerable extent removed by water, and specially by soft water, it is better to boil them in hard water or in water to which salt has been added, in the proportion of 2 ounces to the gallon of water.

As regards vegetables like peas, beans, and lentils, their value as food-stuffs depends to a very great extent on their being thoroughly cooked. It has been shown, for example, that when the meal of such food has been used, baked into cakes, and so cooked and eaten, 91·8 per cent of the albuminous constituent was made use of in the body; but when used in their natural form, and boiled after previous soaking in water, only 59·8 per cent was retained in the body; the rest was expelled undigested as waste. This is doubtless partly because of the meal permitting of more thorough cooking, and partly also, no doubt, because of being more readily attacked by the digestive fluids.

Loss in Cooking.—By the various methods of cooking that have been noted the meat, as might be expected, loses in weight. Obviously the loss will be greater in meat roasted or baked, because of the considerable evaporation of water and melting away of fat. The loss is least by boiling, though by this method of cooking it reaches 20 per cent, that is ⅕ of the weight, so that boiling is the most economical method of cooking. Letheby gives the following table as expressing the loss of different pieces of meat by the various processes:—

	Boiling, per cent.	Baking, per cent.	Roasting, per cent.
Beef generally,	20	29	31
Mutton generally,	20	31	35
Legs of Mutton,	20	32	33
Shoulders of Mutton,	24	32	34
Loins of Mutton,	30	33	36
Necks of Mutton,	25	32	34
Average of all,	23	31	34

The following is an example from another source:—

	In Boiling. lb. oz.	In Baking. lb. oz.	In Roasting. lb. oz.
4 lbs. of Beef lose	1 0	1 3	1 5
4 lbs. of Mutton lose	0 14	1 4	1 6

THE CONSTRUCTION OF DIETARIES.

The previous consideration that has been given to the uses of food in the body, and to the chemical composition of foods, puts us now in the position of being able to calculate with very considerable accuracy the total quantity of food required per day by persons under various conditions of life, and the proportion of the total quantity which should be contributed by the various kinds of food, albuminous, starchy, and fatty.

The principles on which that calculation is based are considered at length on p. 542, and it may be well to restate them briefly here.

1. A certain quantity of food, which must be proteid, is daily required for the repair of tear and wear of tissues, which tear and wear is practically constant, and not notably varying with work done.

2. A further quantity of food, which may be drawn principally from the starchy and fatty classes, is required, varying, however, with the work done and with the external temperature.

Now it is evident that if the tear and wear of tissue, replaceable by proteid or albuminous foods, is more or less constant, it is only necessary to keep a man under observation for some

time to learn how much that daily tear and wear amounts to, and how much nitrogenous food it is necessary to supply daily for its repair. Further, we have seen (p. 533) that even if a man remains perfectly idle, making no exertion whatever, energy is expended in the performance of the vital operations of the body, the beating of the heart, the movements of respiration, &c., and in the maintenance of the bodily temperature. This energy, we have seen (p. 532), is yielded best by the combustion within the body of starches, sugars, and fats, and may be measured by the ultimate products of their combustion which leave the body, specially carbonic acid gas. So that if a set of observations be made upon a man, remaining perfectly idle, one may ascertain not only the amount of nitrogenous food required per day to repair tissue waste, but the minimum quantity also of starches and fats that will suffice to yield energy for vital operations and bodily heat without loss to the body. That is to say, by actual experiment one may learn what is the **Minimum Diet**, consistent with the maintenance of health. If, thereafter, a second set of observations be made upon the same man, who is now set to do a moderate amount of daily work, one may ascertain what is the increased amount of fats and starches, &c., used up in the body to yield the necessary energy, and how much of such foods must be added to the diet to supply it. This set of observations will give the information needed for the determination of what is called **Standard Diet**; that is, the quantity of food daily required by the average man, doing a fair quantity of work, with the maintenance of health. Another set of observations may be made on a man, doing hard work daily, and a dietary may be thereafter constructed to suit his still increased expenditure of energy, and this may be called the **Diet for Hard Work.** Within comparatively recent years a large number of such observations have been made, specially in the Munich Physiological Institute, to which a reference has already been made (p. 540), and a high degree of scientific accuracy has thus been obtained. Previous to such observations the facts which afforded a basis for the construction of dietaries were obtained from observing the quantities of food usually taken by persons under varying circumstances. Thus Dr. Edward Smith calculated the average quantities taken by adult men and women. Dr. Playfair took the average daily food of needlewomen in London, and the average diet of the operatives during the cotton famine in Lancashire in 1862, and considered this to be the barest possible diet. It has been called **Bare-subsistence Diet, Starvation Diet** or **Famine Diet.** Then he took the mean of the dietaries of English, French, Prussian, and Russian soldiers, &c., as representing the diet of active labourers, and so on. In these calculations the large number of cases from which the average was taken got rid of any errors due to individual excess or deficiency in eating.

Bare-subsistence Diet.—Now we have seen (p. 539) that proteid food may be expressed by the amount of nitrogen it contains, and that the amount of proteid consumed in the body may be ascertained by the amount of urea given off in the urine or by the amount of nitrogen that urea contains. Further, fats and starches may be estimated by the amount of carbon given off from the body; only we must not forget that proteid foods yield carbon also. In short, we may express the quantity of food eaten, or of material used up in the body, simply in grains of nitrogen and carbon, as well as in grains of proteids, fats, and starches.

These things must be remembered in endeavouring to understand the following tables. In an experiment in the Munich laboratory, the subject of it, a watchmaker, did no muscular work, received no food, and lost from his body the following:—

Grains of Nitrogen.	Grains of Carbon.
175·2	3202·8

which represented the amount of flesh and fat of his own body consumed as tear and wear of its machinery, and to yield energy and heat for vital processes.

Now Dr. Playfair's bare-subsistence diet of needlewomen and operatives during famine is as follows:—

Nitrogenous or proteid matter,	2·33 ounces	All calculated as free of water.
Fat,	0·84 ,,	
Carbo-hydrates (Sugars and Starches),	11·69 ,,	
Total,	14·86 ,,	

If we express this in grains of nitrogen and carbon it amounts to—

Grains of Nitrogen.	Grains of Carbon.
160·8	3103·4

So that the quantity of material, lost from the body of a starving man in 24 hours, is very nearly the same as the total quantity of food introduced per day into the body in circumstances of hardship just indicated. Exactly

34 ounces of ordinary white bread, that is, 2 lbs. 2 ounces, yield—

Grains of Nitrogen.	Grains of Carbon.
160	4085

almost exactly the nitrogen of the bare subsistence diet, though 900 grains more carbon. So that we may say this quantity of bread per day is the smallest quantity that it is possible for an adult to maintain existence upon. This amount, however, it is plain, is not satisfactory as a calculating basis for ordinary circumstances, for the body loss of a starving man is not a fair gauge of what the body requires even in circumstances of no work to do, nor is the bare-existence diet of a famine-stricken population. Professor Ranke made an experiment upon himself at Munich with the intention of finding what diet was just sufficient for his bodily wants, when he did no work—with what diet, that is to say, his body would hold its own, neither gaining nor losing. The amount is as follows:—

Nitrogenous or proteid, ...	3·5 ounces	All water-free.
Fats, ...	3·5 ,,	
Carbo-hydrates (Sugars and Starches), ...	8·5 ,,	
Total,	14·5 ,,	

This total, it is to be observed, is less than that of the bare-subsistence diet; but then it is less because of the diminished quantity of carbohydrate, while it is richer in proteids, and much richer in fats, fat being worth twice its weight of carbo-hydrate in richness of carbon. Expressed in nitrogen and carbon this diet equals

Grains of Nitrogen.	Grains of Carbon.
241	3675

Dr. Edward Smith calculated the diets for the average men and women doing no work, and made it as follows:—

	Grains of Nitrogen.	Grains of Carbon.
Adult Man, ...	200	4300
Adult Woman, ...	180	3900

Dr. Letheby gives the following for the adult man (1) during idleness, (2) during ordinary work, (3) during hard work:—

Diet should contain	Grains of Nitrogen.	Grains of Carbon.
For idleness, ...	180	3816
For ordinary work, ...	307	5688
For hard work, ...	391	6823

A very large number of statistics have been collected with the object of determining what is a fair diet for the ordinary working-man, and the above are some samples of the means taken to arrive at a decision.

Standard or Model Diet.—The diet generally accepted as a fair representation not only of the total elements which a diet should contain, but also of the proportion of the various food-stuffs of which they should consist, is that of Professor Moleschott, and is given in the following table:—

Alimentary substances in a dry state required daily for the support of an ordinary working-man of average height and weight.

Nitrogenous or proteid, ...	4·587	ounces avoirdupois.
Fatty matter, ...	2·964	,,
Carbo-hydrates, ...	14·250	,,
Salts, ...	1·058	,,
Total, ...	22·859	,,

This table, it is to be observed, gives the quantities calculated free of water. Food as we take it, however, contains varying percentages of water, as the preceding tables of analysis show. If one takes 50 as the average percentage of water, then the 22·859 ounces dry solids will be 45·718 ounces of food as ordinarily consumed. Besides that there is usually taken in one form or another, as tea, &c., at least 50 to 60 ounces of water.

This standard diet, calculated in terms of nitrogen and carbon, yields:—

Grains of Nitrogen.	Grains of Carbon.
316	4860

Putting it in round numbers, we may say that an ordinary person doing a fair day's work requires a quantity of mixed food that will yield 300 grains of nitrogen and 4800 grains of carbon.

The Calculation of the Value of a Diet.—The problem in constructing a dietary is to furnish these ingredients in the simplest, most palatable, most digestible, and probably also most economical form. It will be of interest now to show how the calculations are made, and how, given any diet whatever, one could estimate its equivalents in nitrogen and carbon. The tables of analysis, which have been given in a very complete form, enable one to determine the dry albuminous, fatty, and carbohydrate material in any given food-stuff.

Let us take four examples as illustration: lean beef, white bread, oatmeal, and potato. The problem is to determine the number of grains of nitrogen and carbon in, let us say, four ounces of each of these substances.

1. **Determine what amount of dry nitrogenous (proteid) material, of dry fatty material, and of dry carbo-hydrate (starch and sugar) each contains.**

Lean Beef.—100 ounces of lean beef contain, according to table, p. 543:—

Nitrogenous,	19·3 oz.
Fat,	3·6 ,,
Carbo-hydrate,	none.

If 100 ounces of lean beef yield 19·3 ounces dry nitrogenous matter, how much will 4 ounces yield?—

$100 : 4 :: 19{\cdot}3 : x.$

Multiply 19·3 by 4 and divide by 100.

The answer is ·776 of an ounce.

In the same way, multiplying the quantity of fat in 100 ounces, namely, 3·6, by 4, and dividing by 100, gives the amount of fat in 4 ounces.

Thus

4 ounces Lean Beef contain—

Nitrogenous,	·776 oz.
Fat,	·144 ,,

White Bread.—100 ounces of white bread, according to table (p. 562), contain of—

Nitrogenous,	6·82 oz.
Fat,	·77 ,,
Carbo-hydrate,	52·34 ,,

Proceeding as before,

The quantity of nitrogenous material in 4 oz. is obtained by multiplying 6·82 by 4 and dividing by 100,

of fat by multiplying ·77 by 4 and dividing by 100,

and of carbo-hydrate by multiplying 52·37 by 4 and dividing by 100.

Thus

4 ounces of White Bread contain—

Nitrogenous,	·2728 oz.
Fat,	·0308 ,,
Carbo-hydrate,	2·0936 ,,

Oatmeal.—100 ounces of oatmeal, according to table (p. 563), contain—

Nitrogenous,	16·1 oz.
Fat,	10·1 ,,
Carbo-hydrate,	63·0 ,,

Proceeding as before, we find that

4 ounces of Oatmeal will contain—

Nitrogenous,	·644 oz.
Fat,	·404 ,,
Carbo-hydrate,	2·520 ,,

Potatoes.—100 ounces of potatoes, according to table (p. 569), contain—

Nitrogenous,	2·3 oz.
Fat,	0·3 ,,
Carbo-hydrate,	19·7 ,,

Proceeding again as before, we find that

4 ounces of Potatoes contain—

Nitrogenous,	·092 oz.
Fat,	·012 ,,
Carbo-hydrate,	·788 ,,

These results we may tabulate for ease of future reference thus:—

Amount of Dry Alimentary Substance contained in 4 oz. of Lean Beef, White Bread, Oatmeal, and Potato.

	Lean Beef.	White Bread.	Oatmeal.	Potato.
	ounce.	ounces.	ounces.	ounce.
Nitrogenous,	·776	·2728	·644	·092
Fat,	·144	·0308	·404	·012
Carbo-hydrate,	—	2·0936	2·520	·788
Totals,	·920	2·3972	3·568	·892

2. The next part of the problem is to determine what quantities of nitrogen and carbon these quantities of nitrogenous, fat, and carbo-hydrate material contain.

This we are able to do by a table of Dr. Parkes' in which is stated in grains the quantity of nitrogen and carbon in each ounce of these different classes of foods as follows:—

	Grains of Nitrogen.	Grains of Carbon.
1 ounce of Dry Nitrogenous or Proteid material contains,	69	233
1 ounce of Dry Fatty material contains,	0	345·6
1 ounce of Dry Carbo-hydrate[1] material contains,	0	194·2

To find the grains of nitrogen and carbon, therefore, in 4 ounces lean beef, (*a*) we multiply the number of grains of nitrogen (69) in 1 ounce dry nitrogenous material by ·776, the amount of dry nitrogenous material in 4 ounces of beef, and (*b*) obtain the carbon in the same quantity of nitrogenous material by multiplying by 233, adding to that the carbon contained in the ·144 oz. dry fat, thus:—

	Grains of Nitrogen.	Grains of Carbon.
4 ounces Lean Beef contain in ·776 of an ounce Dry Nitrogenous material:		
·776 multiplied by 69	53·544	
·776 multiplied by 233		180·808
4 ounces Lean Beef contain in ·144 of an ounce Dry Fat:		
·144 multiplied by 345·6,		49·7664
Totals,	53·544	230·5744

Working out the figures for the other substances in the same way, we get results ex-

[1] This does not include lactose, the form of carbo-hydrate in milk, which contains only 175 grains of carbon to each ounce.

pressed in round numbers in the following table:—

Grains of Nitrogen and Carbon contained in 4 ounces each of Lean Beef, White Bread, Oatmeal, and Potato.

	Grains of Nitrogen.		Grains of Carbon.
Lean Beef,	53½	......	230½
White Bread,	19	......	481
Oatmeal,	45	......	779
Potato,	6½	......	178½

These four illustrations have been given to show the method of calculation; and it is evident that, from the numerous tables of analysis given in preceding pages, it would be possible for any one, who knows the multiplication table, to work out the grains of nitrogen and carbon in any ordinary diet.

Thus, let us suppose a person took for breakfast the following:—

4 ounces of Oatmeal made into porridge.
10 ,, Sweet Milk.
1 pint of Cocoa (2 breakfast-cupfuls).
¼ lb. White Bread (two thick slices).
½ oz. Butter (enough for the bread).

We can determine how much of the needed daily supply of nutriment he has been provided with. The method of calculation has already been described.

	Nitrogenous.	Fat.	Carbo-hydrate.
	oz.	oz.	oz.
4 ounces Oatmeal yield,	·644	·404	2·52
10 ,, Milk, ,,	·464	·35	·428 (lactose).
1 pint Cocoa, ,,	·03	·092	·025
¼ lb. (4 oz.) Bread, ,,	·2728	·03	2·093
½ oz. (·5) Butter, ,,	·0115	·4215	—
Totals,[1]....	1·4223	1·2975	4·638 and ·428 lactose.

The calculation shows that the diet yields

Grains of Nitrogen.	Grains of Carbon.
100	1757

Suppose the same man lunches on

½ lb. (8 oz.) Mutton Chop,
1½ lb. Potatoes,

and let us suppose there are only 6 ounces edible material in the mutton, the rest being bone. This will yield, calculating in the same way,

Grains of Nitrogen.	Grains of Carbon.
104	1550

which, added to the breakfast, make 204 of the necessary 300 of nitrogen and 3307 of the necessary 4800 grains of carbon. It will be an excellent exercise for any one who has followed these explanations to construct other one or two meals, just sufficient to yield the 96 grains nitrogen and 1493 grains of carbon still wanting to complete a standard diet for a man doing a good day's work.

Proportion of Nitrogen to Carbon in Standard Diet.—To return to the standard diet, we have found that, for the repair of tissue and for the liberation of energy for work and maintenance of heat, it ought to contain 300 grains nitrogen and 4800 grains of carbon. These figures are exactly equal to a proportion of 1 of nitrogen for every 16 of carbon. Now there is no food-stuff which contains exactly this proportion of these two elements, and the most of food-stuffs are very far from it, the animal foods containing the nitrogen in excess, and the vegetable foods, as a rule, containing the carbon in excess. Thus the proportion is as follows:—

In Lean Beef	1 of Nitrogen to			4⅓ Carbon.	
,, Cow's Milk	1	,,	,,	9½	,,
,, **Human Milk**	**1**	,,	,,	**13⅓**	,,
,, **Oatmeal**	**1**	,,	,,	**17⅓**	,,
,, White Bread	1	,,	,,	25⅓	,,
,, Potato	1	,,	,,	27½	,,

Cow's milk contains evidently too much nitrogen to afford an entirely suitable diet for the adult. Human milk is nearly the proportion, but then we must remember that human milk is the diet for development and growth of tissue, and therefore contains a larger proportion of nitrogen than is needed by the full-grown person. Oatmeal comes nearest, containing rather an excess of carbon. It is evident, then, that the due proportion can only be obtained by an appropriate mixing of food, and that it is not possible to obtain it from one food-stuff alone. Thus Moleschott calculated that to obtain the necessary quantity of nitrogenous food for his standard diet *from one source only*, a person would require to eat of—

Cheese fully	12·4 oz.	Wheat Bread	46·3 oz.
Lentils	15·75 ,,	Rice	82·1 ,,
Peas	18·66 ,,	Rye Bread	92·2 ,,
Beef fully	19·7 ,,	Potatoes	320·8 (20 lbs.)
Eggs ,,	31·0 ,,		

And to obtain the non-nitrogenous material (fat, starches, and sugars), the person would require to consume of—

Rice	18·3 oz.	Rye Bread	30·0 oz.
Wheat Bread	20·0 ,,	Cheese	64·5 ,,
Peas	26·0 ,,	Potatoes	65·5 ,,
Lentils	26·2 ,,	Beef	72·5 (4½ lbs.)
Eggs	29·0 ,,		

[1] Now multiply 1·4213 by 69, and one gets the grains of Nitrogen in the diet.

Then multiply 1·4213 by 233, 1·2975 by 345·6, 4·638 by 194·2, and ·428 by 175; add the results together, and one obtains the grains of Carbon in the breakfast.

The result is, in round numbers,

Grains of Nitrogen.	Grains of Carbon.
100	1757

Thus while $1\frac{1}{2}$ pounds of beef yield the necessary 300 grains of nitrogen, it requires $4\frac{1}{2}$ to give the necessary amount of carbon; so that, to get the necessary amount of carbon from beef, three times the needful quantity of nitrogen is introduced into the body, involving labour in the expulsion of the excess, and probably also working mischief. In the same way if only sufficient rice be eaten to yield sufficient carbon, there is a great deficiency in the supplied nitrogen, and tissue waste is not repaired; while if enough is eaten to yield nitrogen, a great deal excessive carbon is introduced, leading to its being stored up as fat or in some other form.

Instead of expressing the proportion as 1 of nitrogen to 16 of carbon we may express it more simply, though not so accurately, in terms of nitrogenous and non-nitrogenous food-stuffs. When so expressed, we say that a suitable diet for an adult man should contain 1 part nitrogenous food for every $3\frac{1}{2}$ to $4\frac{1}{2}$ parts non-nitrogenous; and this affords one an easier and more rapid way of forming a conclusion as to the suitability of any particular diet. The proportion of nitrogenous to non-nitrogenous constituents of some of the more common foods is as follows:—

	Nitrogenous.	Non-nitrogenous, reckoned as Starch.
Veal,	10	1
Hare's Flesh,	10	2
Beef,	10	17
Lentils,	10	21
Beans,	10	22
Peas,	10	23
Fat Mutton,	10	27
Fat Pork,	10	30
Cow's Milk,	10	30
Human Milk,	**10**	**37**
Wheaten Flour,	**10**	**46**
Oatmeal,	**10**	**50**
Rye Meal,	10	57
Barley Meal,	10	57
White Potatoes,	10	86
Blue Potatoes,	10	115
Rice,	10	123
Buckwheat Meal,	10	130

The only foods that come near to the proportion are human milk, wheaten flour, and oatmeal, the first being deficient in carbonaceous substance and the last in nitrogenous; but the human milk is on this account all the more suited for the growing child, while for an outdoor life, marked by labour and exertion, oatmeal shows itself a well-adapted diet.

Times of Eating.—How is the amount of nourishment shown to be necessary to be introduced into the body? in how many meals? at what times of the day? are questions rather to be answered by each individual, as he finds suitable to his comfort and his business, than to be determined by a code. Certain general rules, however, can be stated with considerable definiteness.

I. The only course consistent with man's business is to introduce the food in several meals, separated from one another by intervals appropriate to the amount taken at each meal, and its nature. There are not very many persons who can devote themselves to any occupation, requiring concentration of thought or energy, soon after a very hearty meal, and it is not desirable that they should. For if a very full meal has been taken, the digestive organs find themselves taxed to their utmost, the circulation becomes exceedingly active through the abdominal organs, meaning a diminished circulation through the nervous system and other parts of the body. This is the explanation of drowsiness after a full meal. Accordingly the diet for the day is distributed in several meals, none of which ought unduly to tax the digestion.

II. The meal-times once arranged should be regularly observed. A habit is very soon established not only with the person himself, but with his digestive organs, which, as the appropriate hour returns, will be prepared, as it were, with the due supply of digestive fluid to meet the expected meal. There is nothing which so disorganizes the paraphernalia of digestion as irregularity, and nothing which is more certain, sooner or later, to establish inveterate dyspepsia.

III. The interval between each recurring meal should be sufficient to permit of a suitable period of rest for recuperation of the digestive energies. What that interval should be may be estimated from reference to p. 601, where the times of digestion of different foods are stated. One may take it that $3\frac{1}{2}$ to 4 hours, on an average, are required for the digestion of an ordinary meal, and, if so, something like an interval of at least five hours should elapse between each meal. Thus if breakfast is taken at 8 A.M., the next meal would not be before 1 P.M.; or if breakfast were at 9 A.M., the next would be at 2 P.M., and the third at 7 P.M., and so on. One must beware of the argument that a shorter interval and more frequent meals may be allowed, if a smaller quantity be taken at each meal. Dr. Beaumont's experiments and observations support the view that, *in a healthy state of body*, a moderately-sized meal is as easily and quickly digested as a small meal. So small

a piece of boiled mutton as a quarter of an ounce will require three hours to digest in the stomach, while half a pound, if properly broken down into small portions by the teeth, will be digested in the same time. It is a chemical operation that is being performed, which, within limits, is not affected in time by the quantity to be operated on. It does appear that a moderate meal and a fair interval between each is more suited to man's internal organization in health than small quantities frequently repeated. The latter is, however, in some cases of ill-health, sickness, &c., the most powerful means of treatment.

The common distribution of meals into three principal meals is the one which seems most suitable, whether these meals be breakfast (8–9 A.M.), dinner (1–2 P.M.), tea (6–7 P.M.), or breakfast, lunch, and late dinner. Many, business men in particular, allow themselves really only two good meals a day, breakfast (8–9 A.M.) and dinner (about 7 P.M.). They snatch a bite early in the afternoon, very often a cup of tea or coffee and a biscuit, or such like, sufficient to stave off feelings of emptiness, but not sufficient to yield any amount of nutriment worth calculating. They find it suits their business; and that if they take anything like a fair meal at that time they are not so active, so quick-witted, or so inclined to business as they wish. That may be so, and yet the fact remains that they supply no fresh fuel for the body just at the time when its energies are being expended with greatest rapidity. It is possible to effect a compromise, and while not taking enough to produce feelings of disinclination for work, yet to take sufficient to yield a fair supply of nutriment to the body—such as a basin of soup with bread, a chop or cutlet and potato, a dish of mince-meat and rice, or mince-meat and potato, and so on.

Breakfast at 9 A.M., dinner between 1 and 2 P.M., and tea about 6, is a very common arrangement with the working-classes of this country. If the tea is a fairly-substantial meal, it is a satisfactory enough arrangement. But it very often happens that the tea, consisting of plain bread and butter and tea, is not a very nutritious diet, and then what really happens is that there is no very substantial meal between the dinner of one day and the breakfast of the next. Under such circumstances a light meal one or one and a half hours before bed-time, say of oatmeal porridge and milk, or pease porridge and milk, or bread and milk, would be a most valuable and useful addition. The writer has known business men breakfasting early, dining at 1, taking tea at 5 in the afternoon, and nothing thereafter beyond a biscuit, with some whisky and water. It was not surprising that, under such circumstances, sleeplessness was a common complaint. With such a distribution of meals, a light supper such as has been indicated ought to be taken. Those who dine late require, of course, no further food before bed-time.

The afternoon tea, so popular with the middle and upper classes, taken between early lunch and late dinner is, under ordinary circumstances, not to be objected to, if the tea be freshly made and not too strong. The individual with inclinations towards indigestion had, however, better take care, lest it suddenly arrests the digestion of his lunch, not yet completed, and brings him to dinner with a stomach most unwilling to receive as yet any further supplies.

It may be remarked in concluding these considerations that the resistance of the body to disease, particularly to infection, is least after a long fast. It is, therefore, undesirable to engage in the day's work unfortified by food, specially if one's business brings one within the reach of any unhealthy influence. "It is well known," says Dr. Combe, "that the system is more susceptible of infection, and of the influence of cold, miasma, and other morbid causes, in the morning before eating than at any other time; and hence it has become a point of duty with all naval and military commanders, especially in bad climates, always to give their men breakfast before exposing them to morning dews and other noxious influences. Sir George Ballingall even mentions a regiment quartered at Newcastle, in which typhus fever was very prevalent, and in which, of all the means used to check its progress, nothing proved so successful as an early breakfast of warm coffee. In aguish countries, also, experience has shown that the proportion of sick among those who are exposed to the open air before getting anything to eat, is infinitely greater than among those who have been fortified by a comfortable breakfast." "In some constitutions," says Pereira, "especially those denominated delicate, much exercise, either of body or mind, before breakfast, operates injuriously, producing exhaustion, languor, and unfitness for the ordinary occupations of the day. These facts show the importance of breakfasting soon after rising and dressing, at least in many cases. I am fully aware that there are numerous exceptions to this. Some persons not only suffer no injury from, but actually appear to be benefited

by, active exercise taken before breakfast, its effect being with them to create or augment the appetite. But in others the effects are those which I have already stated. I am satisfied, from repeated observation, that in children disposed to spasmodic and other brain diseases, the practice of making them attend school for two hours before breakfast is injurious; and I fully agree, therefore, with Dr. Combe, that in boarding-schools for the young and growing, who require plenty of sustenance, and are often obliged to rise early, an early breakfast is an almost indispensable condition of health. Epileptics, and especially those disposed to morning attacks, should invariably breakfast soon after rising. I think I have seen the fits brought on by neglecting this precaution. For travellers a light breakfast before starting is a great protection against colds and subsequent fatigue or exhaustion."

These general rules are all that one can lay down with any pretension to wide application. Within them individuals must consult their own tastes, business habits, and it may be also personal peculiarities. Nevertheless, any one who passes much outside of such general regulations will probably find, in time, that he has erred and incurred the punishment of digestive evils, which once induced are not very easily exorcised.

Variations in Diet according to Age, Sex, Work, or Exercise.—To consider the effect of work and exercise first. We have already had abundant occasion for observing that the broad principle on which diet should be varied with work is, that energy for work is liberated most easily and economically from fats and sugars and starches. So when there is increased work or exercise, calling for more food, the increase should take the form mainly of additions of these to the diet, and not so much of meaty constituents. As a matter of practical experience it is found that some increase in the nitrogenous foods is also demanded, not because of increased tissue waste, but because an increased supply of digestive fluids in the alimentary canal is needed for the digestion of the added supply of food, and these cannot be manufactured in the body without an increase in the quantity of nitrogenous food. Further, it is found that the consumption of foods of the animal kind stimulate the combustion within the body of fatty and starchy materials, and thus the energy is more rapidly liberated from the latter kinds of food when an increased supply of animal, or, to speak more correctly, nitrogenous food is taken with them. Nevertheless it is true that the added labour is to be accomplished at the expense principally of fatty and starchy food.

As regards age: the standard diet applies to the prime of life. Modifications are requisite for the extremes of youth and old age. The relative quantities required for different ages are shown in the following table, which represent the smallest amount of food, according to the investigations of the Munich physiologists, necessary for different ages:—

	Nitrogenous.	Fat.	Carbo-hydrate.
Child under $1\frac{1}{2}$ years, ...	$\frac{3}{4}$ to $1\frac{1}{4}$	1 to $1\frac{1}{2}$ fully	$2\frac{1}{10}$ to $3\frac{1}{10}$.
Child from 6 to 15 years, ...	$2\frac{4}{10}$ to $2\frac{8}{10}$	$1\frac{1}{3}$ to $1\frac{3}{4}$	$8\frac{8}{10}$ to $14\frac{1}{10}$.
Man (moderate work), ...	$4\frac{1}{10}$	2	$17\frac{6}{10}$.
Woman, ...	$3\frac{1}{4}$	$1\frac{1}{2}$	$14\frac{1}{10}$.
Old Man, ...	$3\frac{1}{2}$	$2\frac{4}{10}$	$12\frac{3}{10}$.
Old Woman,......	$2\frac{8}{10}$	$1\frac{3}{4}$	$9\frac{1}{10}$.

The figures denote ounces and fractions of ounces, and the quantity does not include water, but represents the dry nitrogenous, &c., material. By doubling the figures one will obtain the quantities, as applicable to food in the ordinary state in which one consumes them.

As regards the food of children, the really essential thing to remember is that they require a larger proportion of nitrogenous food than the adult, to meet the demand for material with which to build up bone, muscle, &c. Human milk supplies that demand, containing, as we have several times noted, a larger proportion of nitrogen as compared with carbon than is suitable for the adult. On the other hand, these facts are so little known that the prevailing practice is, as soon as a child ceases to be fed with milk, to supply it with food of all others deficient in the very element in which it should abound—corn-flour, tapioca, arrow-root, semolina. These, as we have observed (p. 542), are practically entirely devoid of nitrogen, are almost exclusively starchy in character, and starch is just the class of food-stuff which the child's digestive apparatus is least fitted to deal with. There is no starch in milk, though there is sugar. Such foods are only made tolerable for a child by the milk with which, in part, they are usually made and administered. Well, then, a child's diet ought to be rich in nitrogenous food-stuffs. Here again is oatmeal eminently serviceable, made into well-cooked porridge, with additions of soup, broth, egg, &c., as mentioned in detail on p. 450. With children more frequent meals with shorter intervals are required, prolonged fasting being badly borne. In determining whether a child is receiving a

sufficient diet, one must not lay too much stress upon gain in weight alone. Weight may be gained through deposition of fat, owing to a diet excessively rich in starch, sugar, or fat, while all the time the child is suffering from nitrogen starvation. It is not uncommon to see a big, fat child, which would be called a picture of health but for its pasty complexion, but with bones so soft that they yield to its own weight. Such is the result of a diet too rich in starch, and wanting in nitrogenous food. Therefore, in estimating the health and healthy growth of a child, one must take into account not only weight, but firmness of flesh, redness of lip and cheek, and straightness of bone. Soft flesh, yielding bones, and white face proclaim with absolute certainty improper *quality* of food, no matter what may be the *quantity* the child is consuming. The food of children ought to be given in a more dilute condition than that of adults. They are more likely "to have too little water in their food than too much." "Hardly ever is there a mother or a nurse who imagines that a child can be thirsty without being hungry at the same time. Much discomfort and a good deal of sickness is a result of the fact that infants must eat in order *not* to be thirsty, and have frequently to go thirsty because an over-exerted and disordered stomach will not accept any more food." There is undoubtedly a necessity of mothers now and then giving some water to their children.

The following examples of children's dietaries may be useful:—

St. Thomas's Hospital, London.

(Intended for all Children under 10 years of Age.)

MIXED DIET:—12 oz. Bread; ¾ oz. Butter; ½ pint Milk for Breakfast, the same for Tea; 2 oz. Mutton, when dressed, roast, or boiled alternately; ¼ lb. Potatoes or fresh Vegetables; 6 oz. of Rice or Bread Pudding; ½ pint of Milk.

MILK DIET:—Daily—1½ pints of Milk; 8 oz. Bread; ½ oz. Butter; 6 oz. Rice or Bread Pudding.

Birmingham General Infirmary.

FULL DIET:—Breakfast—1 pint of Milk.
Dinner— 2 oz. Cooked Meat, 6 oz. Potatoes, and 6 oz. Bread.
Supper— ½ pint of Broth or Gruel.

Glasgow Sick Children's Hospital.

	1st (Milk Diet).	2d.	3d (Full Diet).
BREAKFAST, 8 a.m.	Bread and Butter.* Bread and Milk.	Porridge, ½ pint. Bread and Butter.*	Porridge, ½ pint. Bread and Butter.*
DINNER, 12 noon.	Milk Pudding. Extras as ordered.	Broth, ½ pint. Bread. Milk Pudding.	Minced Collops of Beef or Mutton, 2½ oz. cooked, or Stewed Rabbit. Mashed Potatoes, 3 oz. Milk Pudding.
TEA, 4 p.m.	Milk. Bread with Butter.*	Cocoa, ½ pint. Bread with Butter,* Dripping, or Treacle.	Cocoa, ½ pint. Bread with Butter,* Dripping, or Treacle.
	At 5 a.m. and 7 p.m., Milk with "a piece." Total quantity of Milk per day, 1 pint.	Total Milk per day, 1 pint.	Total Milk per day, 1 pint.

* Butter ¾ oz. daily, and Bread as much as is desired.

BROTH.—Alternately Hough and Neck of Mutton, ½ lb. to pint.

PUDDINGS.—Rice, Sago, Tapioca, Bread and Butter with Eggs, all made with Milk and Sugar—Milk ½ pint per Child.

EXTRAS.—Custard (1 Egg to ½ pint Milk), Chicken Soup, Chicken, Eggs, Chops, Fish, Meat-extract, Raw-meat, Beef-juice, Beef-tea (1 lb. to the pint, or stronger if ordered), Jellies, Isinglass, Corn-flour, Arrow-root, Stimulants, Barley-water and Aerated-waters, Cabbage, Turnips.

DINNER.—In order to secure variety, all on Broth and Meat Diet will have a Fish Dinner on Wednesday. On other days the Meat Dinner will go the round of the articles mentioned; and the Sisters will exercise their judgment to suit varying appetites by interchange and sharing of diets, so far as consistent with Medical restrictions.

School Boys about 10 years of age should receive about ½ the nitrogenous food required by active men, and about ¾ths the quantity of carbonaceous food.

Diet for the aged, it has been urged, should, in its kind, approach more nearly to that of childhood. As a rule there is less activity in all the bodily processes, slower heart-beat, slower respiration, and diminished combustion changes going on. All this implies less consumption of material, and is usually accompanied by diminished appetite, weaker digestion, and increased sensitiveness to cold. This implies as a whole less food, and the proportion between the diet of the active man and that of the old man is shown in the table on p. 617. The kind of food given should also be such as will suit the enfeebled digestive powers. Milk may,

with advantage, bulk largely in it, fish, eggs, butcher-meat also, but in diminished amount, milk puddings and so on. Whatever be the opinion as to the use of stimulants by the healthy among young men and women, and men and women in their prime, there is no doubt that the aged feel the benefit of some small amount of stimulant, adding as it does to their relish for food, and aiding its more rapid digestion. An old person cannot with impunity indulge in a full and rich diet, unless he is leading as active and vigorous a life as the man in his prime. The favourite example of how a healthy old age can be attained on a very simple diet is that of Cornara, "a Venetian of noble descent, who lived in the 15th and 16th centuries, and attained an age of upward of 100 years. Impressed with the conviction that the older a man gets and the less amount of power he possesses the less should be the amount of food consumed, in opposition to the common notion that more should be taken to compensate for his failing power; he, at about 40 years of age, resolved to enter upon a new course, and betake himself to a spare diet and scrupulously regular mode of life, after having, as he says, previously led a life of indulgence in eating and drinking, and having been endowed with a feeble constitution and "fallen into divers kinds of disorders, such as pains in my stomach, and often stitches, and spices of the gout, attended by what was still worse, an almost continual slow fever, a stomach generally out of order, and a perpetual thirst." He also did all that lay in his power, "to avoid those evils which we do not find it so easy to remove. These are melancholy, hatred, and other violent passions, which appear to have the greatest influence over our bodies. The consequence was," he goes on, "that in a few days I began to perceive that such a course agreed with me very well; and by pursuing it, in less than a year I found myself (some persons, perhaps, will not believe it) entirely freed from all my complaints . . . I chose wine suited to my stomach, drinking of it but the quantity I knew I could digest. I did the same by my meat, as well in regard to quantity as to quality, accustoming myself to contrive matters so as never to cloy my stomach with eating and drinking; but constantly rise from the table with a disposition to eat and drink still more. In this I conformed to the proverb which says that a man, to consult his health, must check his appetite. . . . What with bread, meat, the yolk of an egg, and soup, I ate as much as weighed in all 12 ounces, neither more nor less. . . . . I drank but 14 ounces of wine." He remained in possession of all his faculties to the close of his life, and wrote his treatises between his eighty-third and ninety-fifth years.

As regards Sex: women require less food than men, when engaged in indoor work—a tenth less, it has been estimated. "Ladies in luxurious repose consume about the same amount as young school-boys." If women are engaged in active outdoor work, as in farm service, their diet approaches more nearly that required for active men.

The Regulation of Diet according to Season or Climate.—The differences in our household arrangements, as regards heating, between winter and summer afford a rough, but very accurate notion of the differences within the body, according to the degree of coldness of the external atmosphere. In cold weather we burn more coals or other fuel to keep up a moderate temperature in the house, and in the body an increased combustion of the heat-yielding substances goes on to maintain the regular temperature of the body. These substances are specially carbo-hydrates and fats, but more particularly the latter. To supply the material for this increased combustion more food is necessary, and particularly more fatty and starchy food. Thus our food should vary in nature and amount with the change of seasons in our temperate climates, just as our consumption of coal varies, or just as the nature of our clothing varies. In persistently cold regions of the earth, in the arctic regions, for example, the inhabitants regularly consume a much larger daily supply of food than anything we are accustomed to; and fatty substances form a very large proportion of the diet. The air in these regions is condensed because of the cold, and a given volume of air will contain a much larger quantity of oxygen than the same volume in a temperate climate, and still more than the same volume in a hot climate. Fats contain a considerably larger proportion of carbon than sugars or starches, and thus the larger quantity of oxygen in the air and the greater proportion of carbon in the fat form the complement of one another, the supporter of combustion and the combustible substance. These facts account for the large quantity of food eaten by the inhabitants of cold regions. It is a matter of common observation in cold climates, or in a very cold season of a temperate climate, that the badly-fed labourer does bad work, and is among the first to succumb to cold. According to Sir John Ross, an Esquimaux will

eat perhaps "twenty pounds of flesh and oil daily," and the children of the arctic regions find fatty substances more toothsome morsels than sweetmeats. According to Sir Anthony Carlisle, "in one of those late extravagant voyages to discover a north-west passage, the most northern races of mankind were found to be unacquainted with the taste of sweets, and their infants made very wry faces, and sputtered out sugar with disgust; but the little urchins grinned with ecstasy at the sight of a bit of whale's blubber." But such an explanation hardly covers the enormous gastronomic feats related by travellers, such as Sir George Simpson's two men of the Yakuti, who in less than two hours and a half consumed each 36 avoirdupois pounds of beef and 18 lbs. of butter. The fact that, after such a feast, the men remain in a state of stupor for three or four days, without further food or drink, and are meanwhile rolled about to promote digestion, shows how abnormal is the diet and how unjustified by the extreme and enduring cold. Great eaters have also been found in climates which made no demand for extraordinary diet—among the Hottentots and Bosjesmans, for example. The point to note is, nevertheless, that a cold external temperature demands a larger than usual supply of food, and that fatty food should bulk largely in the added quantity, the internal combustion of the fat doing far more for the maintenance of bodily warmth than extra clothing.

In warm climates the conditions are reversed, the external temperature may be at certain times above the bodily temperature. Consequently there is less need for liberation of heat within the body. A diminished supply of food is, therefore, required, and of a kind whose combustion will not yield heat in great amount. Moreover the atmosphere is rarefied, and a supply of oxygen for the combustion of highly-carbonaceous food would involve laboured respiration. Rice and sugar contain carbon in much less quantity than fat (see p. 532), 100 parts of starch requiring 120 of oxygen for complete combustion, whereas 100 of fat require 293 of oxygen. Moreover, starches contain a very considerable proportion of oxygen wherewith the combustion may be accomplished, so that starchy foods and other light vegetable diets are evidently best suited for hot climates. The fruits and vegetables preferred by Southerns yield only about 12 per cent of carbon, while the whale's blubber enjoyed by the Greenlander yields 66 to 80 per cent.

The frequency of diseases of the liver in hot seasons and tropical climates, was ascribed by Liebig to the accumulation of carbon in the system. It is, at any rate, due to the accumulation within the body of nutritive material in excess of the bodily demands, and in excess of what the bodily processes can dispose of under the climatic conditions. Thus, speaking of diet in India, Sir Joseph Fayrer says "the diet should be plain and simple. New arrivals should abstain from much animal and stimulating food, with a view to avoid plethora, dyspepsia, malassimilation, and congestion of the already over-taxed liver and eliminative organs. Curries, as generally prepared, should be sparingly consumed." He urges that the mode of living should not be rapidly changed by those arriving from a temperate climate. The habit of the digestive organs is not to be upset with impunity, and therefore the natives should not be copied in respect of diet, but the usual European diet should be gradually modified to suit the altered conditions of climate. Considering the variety of the ordinary British feeding this can be very easily done, the principles being the diminution in the total quantity of nutritive material (which can be done without diminishing the bulk of the diet by substituting articles less rich in nutriment), the substitution of vegetable diet for fatty materials, and increase in fruits. Fayrer says that, as a general rule, people eat too much in India, more than they can assimilate. As an example of a dietary he says, "a cup of chocolate, cocoa, coffee, or tea may be taken before starting for the morning ride or walk; a plain breakfast of the same, with bread and butter and eggs, or a little bit of chicken (more than the bread and butter is not often needed); luncheon or tiffin at 1 or 2 P.M., with very little animal food, a cutlet or the leg of a fowl with vegetables will suffice. . . . The evening is the best time for dinner—the principal meal of the day. It should be plain and simple, with as few dishes as possible. Nothing can be more prejudicial than a great variety and number of highly-seasoned courses. 'To leave off with an appetite' is a good maxim in temperate climates, and better still in tropical. . . . It may be generally stated that temperance both as regards food and drink is of cardinal importance." To every other hot climate besides India these precepts are equally applicable.

In temperate climates a mean between these two extremes is indicated, which is yielded best by a mixed animal and vegetable diet, and which is made to vary in quantity and in the

proportion of the fatty and starchy ingredients with the changes of the season.

It would be a very great benefit to the health of the population of Great Britain if these changes in diet required by the seasons were more recognized than they are, more particularly if the indications for the adoption of a more fatty or oily diet, with the advent of the colder months, were followed. During the cold season it is not cold simply with which we have to contend, but a raw cold, a moist cold, due to the quantity of watery vapour in the atmosphere. On the continent of Europe the cold is often much more intense, but it is more easily borne, because of the crispness and dryness of the air. The cold moist atmosphere robs the body of its heat with far greater quickness and more unequally. The garments become moist, and their power of conducting heat away from the body becomes greatly increased, so that it is a matter of great difficulty, when engaged out of doors, to maintain the bodily temperature at its uniform rate. These are just the circumstances which demand more rapid combustion of highly carbonaceous substances, such as fat, in the body. It is because it meets such a demand that the free use of cod-liver oil as a medicament is found so beneficial in our climate during the winter months, and just for the same reasons that it derives its value in warding off lung affections. Let the lean man, or the young lady who, in spite of her furs, shivers at the bare approach of "chill November," take to cod-liver oil, or to a plentiful supply of fat meats in the dietary, with the close of September, and they will both be compelled to confess that they never passed through a winter with such comfort and with less sensitiveness to the cold.

Diet for Training.—When a person goes into training for the purpose of being fitted for some great exertion of strength or of speed, there are several objects which he wishes to attain by the process. He wishes to increase the vigour of his muscles by adding both to their firmness and their actual bulk; he wishes to free his body of deposited fat; he wishes to increase the expansion of his lungs by developing his respiratory muscles, in order to "increase his wind;" he wishes to increase the strength and regularity of the contractions of the heart, so that its action will not become tumultuous under the exertion; and he wishes to unload of accumulated effete products the organs for the removal of waste, so that they shall be free actively to deal with the waste products rapidly produced under exertion. These objects are accomplished mainly by diet and exercise. Exercise, when properly arranged and graded, increases the tone and actually causes increased development of muscle—the muscles of locomotion, of respiration, and of the heart alike. It is the most rapid means of clearing out the excretory organs, and of causing the consumption of stores of fat and glycogen laid down in the body. The diet to be appropriate must fulfil certain indications. In the first instance it must never be in excess, and it must be of the most easily digested kind. Then it must supply material for the rapid increase of muscular development, and must on that account consist largely of nitrogenous material. Moreover, at the beginning of training, the diet, being mainly nitrogenous, stimulates the consumption within the body of the accumulated fats and carbo-hydrates. At the same time the diet, particularly as the training progresses, when the body has lost its fat, must not be so devoid of fat and carbo-hydrate as to cause the tissue of the body itself to be called upon for the supply of energy, as that would rapidly diminish the power of endurance. This is what "overtraining" leads to. Lean meat, therefore, enters largely into the diet, cooked by broiling or roasting, and not overdone. "Beef and mutton are the meats to be preferred, and it is not necessary that all the fat should be excluded. Stale bread or dry toast, potatoes, and some kind of green vegetables in moderation, are the appropriate articles to be taken in conjunction. Water-cresses are considered good. Pastry, flour-pudding, sweets, and made dishes, should find no place in the dietary of the man in training. The farinaceous articles, as rice, sago, &c., are allowable, but should only be taken to a moderate extent. To avoid too great sameness is an important point, especially with those who have been previously accustomed to a liberal diet; at the same time it is not desirable that the person should be tempted to eat to satiety. A full stomach, as is well known, disposes to inactivity. Condiments, as pickles, sauces, &c., are objectionable, on account of their effect being to force an appetite, which should be simply allowed to have its natural play. . . . The sensation of thirst may be taken as affording a correct guide upon the point of the amount of liquid to be consumed; but instead of drinking freely at a draught to satiety, the liquid should be sipped in small quantities, to give time for absorption, and thus satisfy thirst without incurring the risk of introducing a surplus amount into the stomach. In this way the error is not likely to be committed of drinking

too much. The liquids consumed must be of a simple and unexciting nature. Beer and the light wines are allowable, but spirits should be scrupulously avoided. Tea, coffee, and cocoa may be taken according to inclination, and, as a simple drink, nothing is better than toast and water, or barley-water. The proper number of meals to be taken during the day consists of three—viz., one about 9 A.M., the second between 1 and 2 P.M., and the third in the early part of the evening;" this is how Dr. Pavy summarizes the requirements of diet for training.

The following shows the system adopted at Cambridge in the training for the summer races:—

Rise at 7 A.M. A run of 100 or 200 yards as fast as possible.

Breakfast, at 8·30 A.M., of meat—beef or mutton—underdone; dry toast; tea—two cups, or, towards the end of training, a cup and a half only; and water-cresses occasionally.

Dinner, about 2 P.M., of meat—beef or mutton; bread; vegetables—potatoes, greens; and one pint of beer. (Some colleges have baked apples, or jellies, or rice-puddings.) For dessert, oranges, or biscuits, or figs, with two glasses of wine.

About 5·30 P.M. a row to the starting-point and back.

Supper, about 8·30 or 9 P.M., of cold meat; bread; vegetables, lettuce or water-cresses; and one pint of beer.

Retire to bed at 10 P.M.

Economy in Diet.

"Cheap and nasty" is generally regarded as a saying which is not very often inaccurate when applied to clothing, to furniture, and such like articles. That it is equally applicable to food is a belief not easily dislodged from the minds of the people. Cheap beef must necessarily be inferior beef, the less expensive portions of a carcass must be the poorer portions of it, are articles of this creed; and if there is one class of the population that looks upon the attempt to live cheaply as mean and degrading, it is the class that can least afford to spend more than is absolutely necessary upon the diet. The estimation of the value of food by its cost is wholly arbitrary, and, as we shall see, misleading. If the true method of estimating the value of food-stuffs by their capacity to nourish the body, and the means by which such an estimation could easily be made, were properly understood by the people, a complete revolution would speedily be effected in the dietaries of the poorer classes. Money that is wasted on dearer food-stuffs, under the delusion that they are the stronger and more nourishing, would be saved, if only to give variety by the extras that could be purchased with it, and perhaps to improve the condition of the thrifty in some other direction. A few examples will best show the relation between nutritive value and cost. The following table exhibits the quantity of nutritive material contained in half a pound (8 ounces) of each substance, and its cost:—

½ lb. of Oatmeal	yields of nutritive material	7·136	ounces	at a cost of	1*d.*
,, Fine Flour	,, ,, ,,	6·848	,,	,,	1*d.*
,, Bacon	,, ,, ,,	6·648	,,	,,	5*d.*
,, Pease-meal	,, ,, ,,	6·499	,,	,,	1*d.*
,, Indian Corn Meal	,, ,, ,,	6·424	,,	,,	½*d.*
,, Sago	,, ,, ,,	6·2	,,	,,	1*d.*
,, Peas (dried)	,, ,, ,,	5·995	,,	,,	1*d.*
,, Figs	,, ,, ,,	5·832	,,	,,	2*d.*
,, White Bread	,, ,, ,,	4·794	,,	,,	¾*d.*
,, Dunlop Cheese	,, ,, ,,	4·618	,,	,,	5*d.*
,, Rye Bread	,, ,, ,,	4·349	,,	,,	½*d.*
,, Fowl	,, ,, ,,	2·060	,,	,,	7*d.*
,, Egg	,, ,, ,,	2	,,	,,	4½*d.*
,, Salmon	,, ,, ,,	1·997	,,	,,	7*d.*[1]
,, Lean Beef	,, ,, ,,	1·832	,,	,,	6*d.*[1]
,, Potato	,, ,, ,,	1·784	,,	,,	¼*d.*
,, Cod	,, ,, ,,	1·72	,,	,,	2*d.*[1]
,, Milk	,, ,, ,,	·994	,,	,,	⅜*d.*
,, Buttermilk	,, ,, ,,	·698	,,	,,	⅛*d.*

[1] Allowance is made in calculating the cost for a considerable portion not edible, bones, &c.

Or we may represent the same thing by putting down the quantities of nutritive material 1*d.* will buy in the form of each of these different substances:—

		Nutritive material in ounces.		
1*d.*	will buy	12·848	as	Indian Corn Meal.
1*d.*	,,	8·698	,,	Rye Bread.
1*d.*	,,	7·136	,,	Oatmeal.
1*d.*	,,	7·136	,,	Potato.
1*d.*	,,	6·848	,,	Fine Flour.
1*d.*	,,	6·449	,,	Pease-meal.
1*d.*	,,	6·392	,,	White Bread.
1*d.*	,,	6 2	,,	Sago.
1*d.*	,,	5·995	,,	Peas (dried).
1*d.*	,,	2·916	,,	Figs (dried).
1*d.*	,,	1·864	,,	Buttermilk.
1*d.*	,,	1·329	,,	Bacon.
1*d.*	,,	1·324	,,	Milk.
1*d.*	,,	·923	,,	Cheese (Dunlop).
1*d.*	,,	·86	,,	Cod Fish.
1*d.*	,,	·445	,,	Egg.
1*d.*	,,	·305	,,	Lean Beef.
1*d.*	,,	·294	,,	Fowl.
1*d.*	,,	·285	,,	Salmon.

Taking four of these, and expressing the nutritive material in terms of nitrogen and carbon, we find that—

		Grains of Nitrogen.		Grains of Carbon.		
1*d.*	will buy	90	and	1558	as	Oatmeal.
1*d.*	,,	52	,,	1428	,,	Potato.
1*d.*	,,	50½	,,	1282	,,	White Bread.
1*d.*	,,	18	,,	77	,,	Lean Beef.

Thus one penny's-worth of oatmeal will give almost 5 times the nitrogen of one penny's-worth of lean beef and 20 times the amount of carbon, and three pennies expended on oatmeal will buy 270 grains of nitrogen and 4674 grains of carbon,—almost the very quantity required for the daily supply of a man doing active work.

In the prison of Glasgow the following diet was given to 10 prisoners (5 men and 5 boys), all under sentences of two months' imprisonment, and all employed at light work, picking hair and cotton:—

Breakfast:—8 oz. oatmeal made into porridge, with a pint of buttermilk.

Dinner:—3 lbs. of boiled potatoes, with salt.

Supper:—5 oz. of oatmeal made into porridge, with half a pint of buttermilk.

At the beginning of the dietary eight of the prisoners were in good health and two were in indifferent health; at the end all were in good health, and they had on an average gained more than 4 lbs. each in weight, only one prisoner (a man) having lost in weight. The greatest gain was 9 lbs. 4 oz., and was made by one of the men. The prisoner who was reduced in weight had lost 5 lbs. 2 oz.

This diet contains 302 grains of nitrogen and 5260 grains of carbon, more than the full quantity required per day for active work.

Its cost, including cooking, is 2¾d.[1]

As a final illustration of the fact that the dearer diet is not necessarily the most nourishing, we may give an example of two breakfasts.

We take first the breakfast given on p. 614, the nutritive material of which has been there calculated.

BREAKFAST A,

4 ounces Oatmeal, made into porridge, 10 ounces Milk, 1 pint Cocoa, ¼ lb. Bread, ½ oz. Butter,	Yields 100 grs. Nitrogen, 1757 ,, Carbon,	Costs 3*d.*

BREAKFAST B,

1 pint Coffee, 1 Egg, ¼ lb. Bacon, ½ lb. Bread, 1 oz. Butter,	Yields 79½ grs. Nitrogen, 1792 ,, Carbon,	Costs 5¾*d.*

The advantage here lies with breakfast A, its 20½ grains of nitrogen in excess of B being of more benefit than B's 35 grains excess of carbon. Yet breakfast A consists of half the quantity of bread and butter. It is plain that the egg and bacon, which add to the cost of B, do not yield the nutriment contained in the oatmeal of A. The cost of A would be still further reduced by substituting buttermilk for sweet milk. The cocoa is also counted to the advantage of A, for it contains a large quantity of nutriment, as shown in the table in next section, and, as prepared, the cocoa is all consumed, whereas coffee is used only in infusion, which contains really no nutritive properties, though it possesses markedly stimulating qualities. These illustrations are sufficient to show that a person may live cheaply and yet introduce into the body all the nutriment necessary in a highly useful and digestible form.

Effects of Excessive or Deficient Diet.

The Effects of Deficient Diet are shown in their most extreme form in cases of starvation. In such a condition the tear and wear of tissue

[1] The calculation of the nutritive equivalents is made from the table on page 563, which gives the analysis of the finest oatmeal. Probably the meal actually used would not show such a good analysis, and we may, therefore, allow that probably the diet would scarcely contain so much nutritive material as the calculation represents. Even with such an allowance it is a substantial and sufficient diet. Then the estimate of cost is low, because in a prison, where enormous quantities are bought, it is a wholesale price that is paid, and considering the number cooked for the expense of cooking would be trifling. The same materials bought by the working man or his wife could scarcely cost less than 3¾*d.*

is not replenished, and the amount of nitrogen, expelled in the urine, indicates the exact loss of organized tissue. The amount falls for two or three days after food ceases to be given, as if some surplus proteid matter, not distinctly built up into tissue, were first consumed, and thereafter the amount expelled remains at a certain minimum daily amount, which seems to bear a proportion to the body weight. The material needed to yield energy for vital operations and for the maintenance of heat is derived from the stored-up fat of the body to begin with. Thus after the first few days, when stored-up material is all consumed, the vital functions are carried on at the expense of the tissues themselves, which gradually undergo oxidation to meet the demands. If the temperature of the body be maintained by external means, death by starvation will be delayed, because less consumption of material is necessary to yield heat. It has been found that death occurs in the case of man—cases of complete abstinence from food and drink—in 8 to 10 days, but in some cases it has been observed to be delayed to from 21–24 days; but the period will, of course, depend upon the condition of the body to begin with—upon the quantity of stored-up material it may possess. When water is supplied the period is lengthened. In the case of six melancholiacs, who took water, death did not occur for 41 days. It is remarkable to observe the differing degrees to which the various organs suffer. By the time death occurs almost all fat has disappeared from the body. Next to fat the glandular organs suffer most, the spleen losing 63 per cent of its weight and the liver 56 per cent. The muscles lose 30 per cent, and the blood 17 per cent. The heart and central nervous system lose very little. Their nourishment seems to be maintained at the expense of the other tissues, their activity being so absolutely necessary to continued existence. The immediate cause of death appears to be inability longer to maintain a high enough temperature owing to the combustion of the chief heat-yielding substances. A condition of torpor, similar to that produced by cold, sets in, and leads to death. The person may be roused from this condition by the application of heat; and this is the first thing to be done, in attempted rescue from starvation, viz. to restore bodily warmth, and to supply food very slowly and gradually.

Now if a well-nourished person suffers for a few days only from deficient diet, the tissues of the body will not feel the loss, any stored-up material being sufficient to yield the deficit. If, however, the deficiency be long continued, this stored-up material will disappear sooner or later according to the daily amount of the deficiency, and, thereafter, any continued deficit will have to be made good from the tissues themselves, so that a modified and slow state of starvation will arise, weight will be steadily lost, and the characteristic results of the deficit will appear. This state of modified starvation may arise, even though the diet may appear to be abundant in quantity, and even though the person may actually gain in weight. Thus a diet may regularly contain more fats and carbo-hydrates than the person requires for energy and heat, excess being stored in the body, but the diet may, at the same time, be deficient in nitrogenous foods, so that the person is daily expelling from the body, as the result of tear and wear, more nitrogen than the diet yields, the excess of expenditure over income being drawn from the muscles, &c., while the loss in nitrogen is not in bulk so great as the gain in fat, and is, therefore, masked. A state of nitrogen starvation may thus arise while the person becomes actually fatter. This is not so uncommon among children fed on too starchy food. The evidence of this would be found in the absence of a healthy colour and in the flabbiness of the muscles and thinness of the bones felt beneath the fatty layer under the skin. As a rule, however, defective diets are so all round, and general leanness, loss of strength, languor, and general weakness betoken the true condition.

The Effects of Excessive Diet are much more common than those of defective diet. There is no doubt that many people habitually eat to excess, being urged thereto by sauces, condiments, stimulants, &c. With a plain, simple fare, a healthy appetite usually speedily indicates when the stage of satisfaction has been reached, and there is little temptation to pass beyond it. But with a great variety of food, made dishes, and culinary devices, healthy instinct is confused or disobeyed. A single excess will, of course, lead only to temporary disturbance, but continued excess leads to marked and wide-spread disturbance. Fat accumulates in the body, the liver becomes oppressed with its stores of unnecessary material, digestion becomes impaired from the excessive demand upon its operations, the attempt to dispose of the excessive material burdens the organs of excretion, and, owing to their inability to dispose of all the waste products, effete matters remain in the circulation. The blood charged with such materials is less fit to nourish the body, and

organs, not at first concerned, become thus affected indirectly, notably the brain and nervous system. Thus indigestion, sluggish and gorged liver, disordered bowels, headache, sleeplessness, plethora, giddiness and irritability are among the earlier results. Gouty and other allied conditions may arise. The evils from excess in animal food are more marked than from excess in vegetable food. Deposition of fat, disordered liver, and so forth, readily arise in the latter, but the retention within the system of the products of nitrogenous excess, introduced to greatest extent in animal food, are more particularly injurious. Whenever, with excess of food, there is deficient exercise, the evils are greatly magnified, and it is under such circumstances that the evils of excessive animal food appear in full force.

Diets suitable for Special Bodily Conditions.

Corpulence, and Banting's System.—William Banting was a London tradesman who, at sixty-six years of age (Aug. 1862), with a height of 5 feet 5 inches, weighed 14 stones 6 lbs. In spite of a most active life, without self-indulgence of any kind, he suffered from what he calls the "lamentable malady" of ever-increasing stoutness. He was compelled to go down-stairs slowly backwards to save the pain of the weight on his ankle and knee joints, and the slightest exertion made him puff and blow. He complains pathetically of the pain inflicted on him in the street or in public assemblies by the remarks of the "cruel and the injudicious." He had "tried sea-air and bathing in various localities, with much walking exercise; taken gallons of physic and liquor potassæ advisedly and abundantly; riding on horseback; the waters and climate of Leamington many times, as well as those of Cheltenham and Harrogate frequently; have lived upon sixpence a-day, so to speak, and earned it, if bodily labour may be so construed." At last he was advised to abstain from all fat and fat-making articles of diet, and in thirty-eight weeks he had reduced his weight by 35 lbs., while in twelve months he had reduced it by 50 lbs., and weighed 10 stones 12 lbs. His original dietary was "bread and milk for breakfast, or a pint of tea with plenty of milk, sugar, and buttered toast; meat, beer, much bread, and pastry for dinner; the meal of tea similar to that of breakfast; and generally a fruit tart or bread and milk for supper." His altered diet was as follows:—

Breakfast at 9 a.m. 5 to 6 oz. of beef, or mutton, or kidneys, or broiled fish, or bacon, or cold meat of any kind except pork or veal; a large cup of tea or coffee (without milk or sugar); a little biscuit or 1 oz. of dry toast; making altogether 6 oz. of solids and 9 oz. of liquids.

Dinner at 2 p.m. 5 or 6 oz. of any fish except salmon, herrings or eels; any meat except pork or veal; any vegetable except potato, parsnip, beet-root, turnip, or carrot; 1 oz. of dry toast; fruit out of a pudding not sweetened; any kind of poultry or game; and two or three glasses of good claret, sherry, or Madeira; champagne, port, and beer forbidden; making altogether 10 to 12 oz. solid and 10 oz. liquid.

Tea at 6 p.m. 2 or 3 oz. cooked fruit, a rusk or two, and a cup of tea without milk or sugar; making altogether 2 to 4 oz. solids and 9 oz. liquid.

Supper at 9 p.m. 3 or 4 oz. of meat or fish, similar to dinner, with a glass or two of sherry and water or claret; making 4 oz. solids and 7 oz. liquid. For night-cap, if required, a tumbler of grog (gin, whisky, brandy, without sugar), or a glass or two of claret or sherry.

The principles involved in this diet are quite evident. The starch, sugar, and fat of the diet are reduced to a minimum. They are, as a matter of fact, less than is sufficient for the liberation of heat and energy. Consequently, the stored-up fat of the body would be drawn upon to yield what was deficient in the diet. In the second place, the richness in nitrogenous material would stimulate oxidation changes, and, aided by exercise, would hasten the consumption of the deposited fat. The diet was successful with Banting, but as a matter of fact it is a modified starvation diet, from its deficiency in non-nitrogenous substances, and many people would find its employment attended by serious results. It is not, therefore, to be hastily tried by everyone with a tendency to stoutness. Its principles, however, may be gradually put in force and extended as the person finds his organization becoming accustomed to them. They are chiefly these: avoidance of all foods rich in carbo-hydrates, or very sparing use of them, notably potato, white bread, rice, sago, tapioca, corn-flour, semolina, sweets, sweet fruits and sweet vegetables—like carrot, turnip, parsnip, beet-root—reduction of fat, butter, cream, and abstinence from sweet wines and ales.

On the other hand, there are allowed all kinds of lean meats, lean fowl, and lean fish, eggs, game, green vegetables, succulent fruits, natural wines, bitter ale in small quantity, and spirits. Brown bread should be substituted for white. It may be added that the large quantity of wines and spirits consumed by Mr. Banting is too great for commendation.

Professor Ebstein of Gottingen has a plan which differs nothing in principle from that of Banting, but which tries to avoid its risks. "Sugars, sweets of all kinds," he says, "I forbid unconditionally. The quantity of bread is limited at most to 3 or 3½ ounces a day, and of vegetables I allow asparagus, spinach, the various kinds of cabbages, the legumes, whose value as conveyers of albumen, as Voit observes, is known to few. Of meat I exclude none, and the fat in the flesh I do not wish to be avoided, but, on the contrary, sought after. I permit bacon fat, fat roast pork and mutton, kidney fat, and, when no other fat is at hand, I recommend marrow to be added to the soups. I allow the sauces as well as the vegetables to be made juicy, as did Hippocrates, only for his sesame oil I substitute butter." "The permission to enjoy certain succulent things, always, of course, in moderation—as for instance salmon, pâté de foie gras, and such like delicacies—reconciles the corpulent gourmet to his other sacrifices. These consist in the exclusion of the carbo-hydrates."

The name of Professor Oertel of Munich is also identified with a cure for "growing too fat." It does not differ in principle from Banting's. But it allows fat to the extent of from 1 to 1¼ oz. per day, and it allows rather more carbo-hydrate, 2½ to 3½ oz. Ebstein allows 3 oz. fat per day, and only 1¾ of carbo-hydrate. Whereas, in Banting's diet, the fat was reduced to ⅓ oz. and the carbo-hydrate to 2¾ oz. per day. Oertel's allowance of albuminous food is nearly the same as Banting's, 3½ to 6 oz. per day, while Ebstein permits only 3½. The feature of Oertel's plan is a series of regular and graded exercises and gymnastics, specially by the enforced exercise of climbing heights.

Diet for Diabetes.—This has been so fully entered into on p. 303 and subsequent pages that further details are not necessary here. It may only be remarked that the diet rigorously excludes carbo-hydrates. The difficulty often is that the excess of nitrogenous diet threatens mischief to the kidneys, and one has to face the question whether a less rigorous exclusion of carbo-hydrates, by necessitating less albuminoid food, may not be less hurtful to the kidney. It is of doubtful advantage to reduce, almost to nothing, sugar expelled by the urine if the method taken to achieve this has lit up a serious kidney disease.

Diet for Gout.—Gout has been sufficiently described on p. 432. One of the chief features in gout is an interference with the due oxidation of proteids, leading to an accumulation in the system of uric acid or urates. The indication, so far as diet is concerned, is the restriction of proteid foods, and especially proteid foods derived from the animal kingdom. Fowl, fish, and milk are quite permissible in the diet, so also are sweetbreads and tripe, if taken in moderation. Of vegetable foods the gouty person should eat liberally—potatoes, carrots, turnips, parsnips, beet, broccoli, Brussels sprouts, cabbage, spinach, endive, lettuce, celery, beans, peas, kale, onions, leeks, salsify, cucumber, marrow, &c. Milk puddings are allowed, if they are made without egg. Custards and omelettes are forbidden, so also are jellies. Pastry is better avoided. Fruit puddings and fruits are suitable. A very small portion of a fat cheese may be permitted, considering its smallness. Of as much importance as the meat is the drink of the gouty person. It would appear as if, in many instances, it is the liquor that is consumed that somehow or other interferes with the proper oxidation of the nitrogenous food and provokes a gouty attack. Malt liquors, all rich and sweet wines, specially port, champagne, &c., are most injurious. Claret, whisky or brandy, and aërated water are the only alcoholic drinks of which the gouty may partake, but always in great moderation. Withal, the dieting is only of great value when combined with regular exercise. If sedentary habits are indulged in, the oxidation of the proteids will still be incomplete, and attacks, though modified, will still recur.

Diet for Rheumatism.—Flesh meat is restricted in rheumatism, and only the lighter and less rich kinds of animal food allowed, such as chicken and fish. Vegetable food is freely given, lemons and lemon-juice being specially commended. The desire is to diminish the acidity of the blood, and this is readily accomplished by a diet poor in animal food and rich in vegetable.

Diets for Invalids.

In the following paragraphs the object is to examine some of the foods which are supposed to be, or actually are, particularly nourishing and digestible, and therefore specially suitable

for those whom ill-health has rendered unable to make use of ordinary foods, however light and well-prepared. Without attempting any definition we may say that an invalid has, as a rule, a poor appetite, a weak digestion, and a marked difficulty in making good use of the food that is consumed. So that the indications that ought to be fulfilled by food for invalids is that it shall contain a large quantity of nutritive material, so that even a small quantity shall supply a fair amount of nourishment, that nevertheless it shall not tax the digestion, and that it shall be pleasant and slightly stimulating to the palate. The fulfilment of these conditions is by no means an easy matter. Let us look, first of all, at that preparation, the first and the last resource of the sick-nurse and the detestation (as a rule) of the invalid, beef-tea.

Beef-tea is usually made by cutting up the meat into small pieces, allowing it to steep in cold water for some time, then putting it into a sauce-pan and letting it simmer for some hours. The fluid parts are then poured off, the solid portions, which are tasteless and tough, and, therefore, according to popular notion, valueless, are thrown out. Now what is the value of such a preparation? *As a food it is almost valueless,* and, therefore, does not fulfil the first condition of an invalid dietary. The steeping in cold water extracts the flavouring matter of the meat, the extractives (see p. 537), and the tea has consequently all the flavour of beef, and promotes the delusion that it is nutritive. The cold water extract contains also a fair proportion of soluble albuminoid, but this is coagulated and precipitated by the subsequent prolonged simmering, and much of it is left behind when the fluid parts are poured off. Such a preparation has advantages, no doubt—it is stimulating, invigorating, and is at first enjoyed, though its constant repetition usually brings aversion—*but it is not nourishing.* We have seen that lean beef (for fat meat invalids cannot digest) contains as its principal nutritive material (see p. 543) nitrogenous materials, that is proteids, the myosin of the flesh. If beef-tea is to be worth anything as food it must contain as nearly all of the albuminoids of the beef as is possible. There is only one way of effecting this, and it is by reducing the meat to a pulp, preferably by scraping. Take 1 lb. of lean beef. If it is in one thick slice it will be more easily scraped. Let it be scraped by a knife, and the scrapings removed to a jelly-can. The process is tedious and laborious, and excessively tiring to the wrists. If it is properly done the whole of the red portion of the beef will be reduced to the finest pulp, so fine that when diffused in water it will not be perceptible to the tongue, and the tendinous, fatty, and stringy parts will be left behind, but completely stripped of red flesh. To this pulp in the can add 2 imperial pints of cold water, that is one breakfast-cupful to each ¼ lb. of beef, and a very small quantity of salt. Place the jelly-can, uncovered, in a sauce-pan of hot water, put a tight-fitting lid upon the sauce-pan, and place it at the side of the fire for 2 or 3 hours, *never allowing it to become so hot as even to simmer.* It is then kept in a covered vessel and used as required. After standing for a time the meaty pulp settles, so that the whole needs to be stirred before any is removed for use. Of the contents of the jelly-can none is unused. There are no lumps to be removed. The value of this beef-tea can easily be estimated, because it contains all the nitrogenous constituents of the beef, but very little fat. Before being given to the invalid it may be thickened by means of flour, rice, corn-flour, bread-crumbs, &c. Let a tea-cupful be taken in a small pan, and let the necessary amount of rice, corn-flour, &c., be stirred into it, and allow the whole to be very slowly brought just to the boiling point. It is then seasoned to taste. Where rice is used it should be cooked before being added to the beef-tea. The bringing to the boiling point does not injure the meaty portions, when in the form of so fine pulp and when kept from precipitation by the thickening. Now such a beef-tea is of a very fine delicate flavour, not of the strong taste prolonged cooking at a high temperature produces, and the flavour can be modified or entirely altered by the nourishing additions that may be made to it, so that sameness is avoided. Such beef-tea is a true food, it is easily digested because of the fine state of division of the meaty portion and because of the method of cooking, and in the writer's experience it is a most palatable and enjoyable dish.

Two breakfast-cupfuls will contain 107 grains of nitrogen, and probably 150 to 200 grains of carbon, that is not including the value of the added flour, &c.

Liebig's method of preparing beef-tea is as follows:—Half a pound of raw lean beef (chicken or other meat may be also used) is finely minced, placed in a glass or earthenware vessel with ⅞ths of a pint of water, to which four drops of muriatic acid and half a tea-spoonful of salt have been added. The whole is well stirred and then allowed to stand for an hour. Thereafter

it is strained through a hair sieve, and the sieve and residue washed with five ounces water. This is taken cold or only very slightly warmed. It contains not only the extractives, but also a considerable amount of soluble albuminoid, which, if it were boiled, would coagulate. It is not cooked at all, and the raw meat colour, smell, and taste, it possesses sometimes cause it to be objected to. Besides such home-made preparations the invalid has now at command an enormous number of prepared foods, extracts of meat, beef jelly, &c. Nearly all of them possess the qualification of being pleasant to the palate, and easily digested, for most of them contain very little to digest. With one or two noteworthy exceptions, they contain very little real nutriment. All of them are more or less rich in extractives, and thus possess stimulating characters of a high order. But stimulation is not nutrition, any more than blowing with the bellows a low dying fire can be used as a substitute for putting on more coals. The bellows may cause the embers to flare up and burn rapidly, but only the sooner to burn out. It is true that on the low fire one may place plentifully a fresh supply of coal, but it may be so low that it is unable to set fire to the new coal, and so goes out in spite of it. But then if we supply fresh coals and also use the bellows, we shall quicken the dying flame till it has got a sufficient hold of the coal to make it burn briskly without further help. Just so it is of little use to supply a beef-tea which only stimulates and gives no new supply of bodily fuel. If the patient be so weak as not to be able to make use of nourishment without aid, supply the stimulant also, so that the weak energies may be sufficiently roused to benefit by the nourishment. There seems to be no manner of doubt that many persons, exhausted by acute disease, fail to rally when the crisis is past, because they are plied with beef-teas, beef extracts, and so on, under the vain delusion that they are being supplied with nourishment, when they are practically being starved with the smell and flavour of the meat, with its shadow but without its substance.

An excellent example of this is found in the most popular, at least till recently, of all extracts of beef, Liebig's. Each pound of this substance is said to be the "extract" of 45 to 48 pounds of ordinary butcher's meat, and was at first by Liebig himself believed to possess highly nutritive power. Voit, whose name we have so often mentioned in these pages, showed by actual experiment that it failed to maintain life even for a brief season when used as an exclusive diet. This is indicated by its analysis, which shows the chief constituents to be as follows:

Albuminous constituents, 7 per cent (about ⅓ that of beef).
Extractives, nearly .... 8 ,,
Salts, ...23 ,,

It is, therefore, rich in extractives and salts, to which it owes its flavour and stimulating properties, but poor in nutriment.

A large number of other extracts are not very dissimilar. Valentine's meat juice, made by submitting steak to great pressure, and then evaporating the obtained juice in vacuo to the consistence of syrup, contains, according to the same authority, 6½ per cent of albuminoids, 1½ per cent of extractives, and 11½ of salts. Brand's essence contains over 8 per cent of albuminoid, $\frac{1}{10}$ per cent of extractives, and nearly 1½ of salts. Murdoch's liquid food contains 13 per cent of albuminoids, nearly $\frac{2}{10}$ths extractives, and $\frac{5}{10}$ths salts. Savory and Moore's fluid beef possesses 8 per cent albuminoid, 7½ of extractives, and 12 of salts. A great improvement on these, from the nourishing point of view, are Johnston's fluid beef and Kemmerich's extract of beef; the former of which contains 35 per cent of albuminoids, 1½ of extractives, and 15 of salts, while the latter shows 22 albuminoid, 6 of extractives, and 18½ of salts.

Now the difficulty of getting the nutriment of the beef into extracts such as these is the difficulty of solution. The nutriment becomes insoluble with a high temperature, such as is employed in the manufacture of most of them. One recent method of getting over this difficulty is by the use of artificial digestive agents, which convert the albumin into the form of peptone, which is soluble and not precipitated by heat. This is done by allowing the meat to be acted on by pepsin or pancreatin, both digestive agents, and then making an extract of the soluble parts. This has for invalids a double advantage. It makes the extract more nutritious, and since the albumin is either wholly or partially digested, it passes easily into the circulation without trouble to the weak digestion of the patient. Of such peptonized food or peptones there is now a great variety. Savory and Moore supply a dry meat peptone which can be conveniently added to other food. Peptonized beef jelly, peptonized chicken jelly, peptonized cocoa and milk, and so on, are made by them and other chemists. Many of them are still deficient in nutriment, and yet more valuable than the ordinary extracts. Benger's pep-

tonized beef jelly contains over 4½ per cent of peptone, and 2½ other albuminous substances. But chief of all such foods, in the writer's opinion, is Carnrick's beef peptonoids. It is in the form of a dry powder, containing only 6⅔ per cent of moisture. It contains no less than 63½ per cent albuminoid, of which 7 per cent is peptone. Besides it contains 10½ per cent fat, and 5½ salts. The makers assert it to be made of beef, reduced to powder, and fine wheat flour and milk dried to a powder. Of its highly nutritious qualities there is no possibility of doubt. Its only disadvantage is a not too agreeable flavour, which is, as a rule, not enjoyed by invalids. But then the powder may be mixed with hot water, as cocoa is, and seasoned to taste. If advantage is taken of the pleasant flavour of Liebig's extract, and a small quantity stirred in with the Carnrick's powder, a highly nourishing, pleasant, and stimulating fluid food is obtained. It can also be stirred with milk and used in other ways.

Anyone can now also prepare peptonized foods for invalids by using the pepsin powder, or pancreatin, or the liquor pepticus, or liquor pancreaticus, obtainable from every chemist. Milk, beef-tea, soups, &c., can be so peptonized before being given to invalids. All that is necessary is to bring the milk, beef-tea, &c., to a lukewarm temperature, then to stir in the powder, or liquid—pancreatin or liquor pancreaticus would be best—and keep the mixture warm for half an hour or thereby. With any of the preparations now in the market full directions can be obtained, so that no one need be at a loss how to proceed. (See below.)

The less nutritious forms of extract may still be of great value in the dietary of invalids, provided always people will remember that they are not to take the place of foods, but are to act as stimulants and excitants to appetite and digestion. They are to be used only as food adjuncts. If they are used simply to stimulate the taking of other and nutritious food, supplied with them, they will be used in their proper place, and will be of great value. If they are permitted to form the main diet of the invalid, the unfortunate will starve.

Diets for Infants.

Sufficient has been said elsewhere, in previous pages, as to appropriate diet for infants and young children. The object of these paragraphs is to point out the nature of a few of the foods offered now in great variety in the market as substitutes for mother's milk.

If mother's milk be taken as a standard, then infants' food should contain 1 of nitrogenous to every 3 non-nitrogenous constituent (see p. 615), or 1 of nitrogen to every 13 of carbon. The best known of such foods are Savory & Moore's, Nestlé's, Ridge's, Mellin's, Neave's, Carnrick's, and Benger's. The proportions of the two kinds of constituents are as follows:—

	Nitrogenous.		Non-nitrogenous.
Carnrick's	1	to	4½
Neave's	1	,,	5½
Franco-Swiss Co. Milk Food	1	,,	6½
Savory and Moore's	1	,,	7
Benger's	1	,,	7½
Nestlé's	1	,,	7½
Ridge's	1	,,	9⅛
Mellin's	1	,,	9½

In many of them not only is the proportion of non-nitrogenous material too high, but it consists largely of starchy material not easily digested by the child, and too little in the shape of fat (like the butter of milk) and sugar. In Ridge's this insoluble form of carbo-hydrate exists to the extent of over 78 per cent, in Neave's 73 per cent, in Savory & Moore's 70 per cent, in Benger's nearly 66 per cent. In Carnrick's it falls to 41½, in Nestlé's 35½, in the Franco-Swiss Company's to 37½, and in Mellin's to 18½; but Mellin's and Nestlé's, and we may say also the Franco-Swiss Company's, are too poor in nitrogen. In the matter of infants' food, also, analysis seems to show Carnrick's to be superior to the others. It contains 5 per cent of fat, Nestlé's 4½; all the others contain scarcely 2 per cent, and Mellin's barely 1 per cent. Therefore we give it as an opinion, based upon the proportion of nutritive ingredients, that Carnrick's soluble food comes nearer to what an infant's food should be than any of the others.

Besides in the form of such prepared foods, there are now other methods of administering foods to delicate children of a very reliable character. Cow's milk sometimes disagrees with children, because it forms a large curd in the stomach in process of being digested. If boiling the milk does not prove a satisfactory method of overcoming this difficulty, partially digesting the milk will. For this purpose peptic or pancreatic juice may be added to the milk, and the milk then allowed to stand for half to three-quarters of an hour in a warm place. It should not be allowed to stand too long, lest a bitter taste is developed. The peptic or pancreatic juice partially digests the casein of the milk, so that when swallowed it no longer curdles in large masses. The most reliable forms of such juices are Savory & Moore's of London, or

Benger's of Manchester. A very convenient means of predigesting milk or other food-stuff, such as home-made beef-tea, &c., is supplied by London chemists, Burroughs, Welcome & Co., in the form of peptonizing powders. They are in little tubes, each containing some pancreatin and carbonate of soda, enough for 1 pint of milk. It is advised to add ¼ of a powder to ¼ of a pint of milk diluted with a ¼ pint of cold water. The glass containing the mixture is made to stand in another vessel containing water as hot as the hand can bear for 10 to 20 minutes, before the mixture is given to the child. If it is not to be given at once, the mixture is, after the lapse of twenty minutes, brought to the boiling point to prevent further action of the ferment, which, otherwise, would go on acting, and would produce a bitter taste. By such predigesting of milk—and, as already said, any other food-stuff may be similarly acted on—serious digestive troubles may be overcome.

THE PRESERVATION OF FOOD.

In the first part of this book, in Section XIII. (p. 384), it has been shown in great detail how putrefaction and decay are the work of living organisms or germs deposited from the atmosphere, which, however, can be destroyed, or whose work can be prevented, by various means. The part played by such organisms in the economy of nature has also been indicated (p. 390). The living agents of putrefaction perform, we have seen, an indispensable work in the cycle of natural processes, whereby the lifeless, and in that condition useless, organic mass is resolved into its inorganic constituents, with their endless possibilities of reconstruction and revivification. But, from a human point of view, their range of operation is too unlimited, their attack too rigidly impartial, too universal, too regardless of the fitness of things, humanly speaking. For a large and necessary element in man's food is organized material readily surrendering to the attack of germs. Man's wanderings on the earth are not conditioned mainly, as are those of lower animals, by the quest of food, nor is the population of different regions determined by the abundance or scarcity of provision. Rather, indeed, as the population increases does the capacity of that region to maintain its inhabitants diminish. Thus it early became a question whether food could be preserved from the inroads of putrefaction, to permit of its transport from the place of abundant supply to the place of scarcity, and whether food, to be obtained in abundance only at one season, could be preserved to the season of scarcity. It must have been early observed that moisture and heat were two conditions necessary for putrefaction, and that the absence of these conditions favoured preservation. The natural preservation of grain must speedily have shown this, and the application by man to fruits, like grapes and currants, could not long be delayed. It appears, moreover, that this process had long ago been applied to animal food, for in the British Museum there are to be seen specimens of dried poultry, taken from Egyptian tombs, which are supposed to have been placed there thousands of years ago. **Tasajos** and **charqui**, or jerked beef, are varieties of meat prepared in South America by drying, after being dipped in brine. Similar to these is the **beltong** of the Kaffirs and the **pemmican** of arctic voyagers, the latter consisting of fat as well as of the red flesh and being also mixed with sugar and spice. In France in 1386 dried yolks of eggs were pounded and stored in barrels as provision for the army. In recent days similar methods have been applied to vegetables, potatoes, cabbage, carrots, cauliflowers, &c. The drying process, however, at least as applied to beef, seriously affects the meat so far as its nutritive qualities are concerned, and renders it tough, difficult of being cooked, and not easily digested. The practice of embalming shows also that the ancients understood that the decay of animal bodies could be prevented by chemical means, while the custom of swathing bodies in waxed and resinous bandages and inclosing them in leaden coffins, shows that they had some idea that atmospheric air was a principal agent in producing the putrefactive change. Nature herself indicated the power of cold to arrest decomposition. In Russia and other northern countries it is a common custom to kill fat cattle in November, when fodder grows scarce, and bury them in the ice or frozen earth till the beginning of May, and to pack poultry in tubs with layers of snow between them. The value of cold as a preserving agent was brought prominently before the public mind by the discovery of the mammoth at Jacutsk in Siberia, in a perfect state of preservation, embedded in a block of ice upwards of 200 feet high, an animal whose structure indicated its belonging to long bygone ages, and by the recovery in 1861 of the bodies of three Chamounix guides who had been carried away from the grand plateau of Mont Blanc by an avalanche forty-one years before.

So that the preservation of food by drying, by chemical means, by the exclusion of air, and by the use of cold, might almost be considered as parts of ancient history. Yet no method seems to have been extensively adopted till quite recent times. But with the development of ocean navigation and voyages of discovery the necessity of adopting some reliable methods became the spur to invention. The method of drying was too coarse in its results, and chemical means were not desirable, from the point of view of the palate. Salt, used for such purposes from the earliest times, which rendered the meat hard and indigestible, as well as less nutritious by extracting some of the nutritive juices of the meat, proved itself to possess more fatal objections to the long voyager, when out of an expedition of 961 men, 626 were lost by scurvy, the attendant of a diet too abundant in salt junk and destitute of fresh provisions. How urgent became the demand for better methods is evident from the fact, that while in the seventeenth century only one patent for the preservation of food was described, and only three in the eighteenth, as many as 117 were specified in the first fifty-five years of the present century, and since then they have been very numerous. Some of these were for drying processes, such as that by which Liebig's extract of meat, Hassal's flour of meat, Blumenthal and Chollet's meat and vegetable tablets, &c., are prepared; others were for chemical processes, such as the employment of sulphurous acid or carbonic oxide gas, or the injection of meat with chemical agents. The chief patents, as now appears, were those which proposed to exclude the atmospheric air or to employ cold. One method (Plowden's, 1807) proposed to exclude the air by incrusting the meat with some substance which would resist the action of the air, and the substance used was a hot extract of meat; another proposed to coat the meat with impermeable varnish. These failed, and we now know the reason. It is not the air in itself that effects the noxious change, but the living germs deposited from it. These already would be deposited on the meat before the coating was applied, and under cover of the impermeable coating could calmly proceed about their ravages. Augustus de Heine, in 1810, proposed to place the food in closed vessels and then to withdraw the air through a valvular aperture by a special exhausting apparatus. That method, too, was found to fail for similar reasons. In 1807, however, T. Saddington, of London, proposed to preserve fruits without sugar, by placing them in bottles, *driving air out the bottles* by heat, filling them up with boiling water, and then tightly corking them. The bottles, filled with fruit to the neck, were placed in a water-bath, the water of which was gradually heated up to 170° Fahr. Then the boiling water was poured in. For his method Saddington received a premium from the Society of Arts. Three years later, in 1810, a Frenchman, Appert, applied the method to meat, vegetables, fruit and milk, receiving as the reward of his labours 12,000 francs from the French government. Appert first partially cooked his provisions. He then placed them in strong bottles which he filled up to the neck. The bottles were then well corked, and the corks were covered with a luting of cheese and powdered lime, which he said rapidly hardened and was then able to resist the action of boiling water. The bottles were then wrapped in coarse canvas bags and placed up to the neck in a boiler of cold water. The boiler was covered and heat applied till the water boiled. It was kept boiling for an hour or more. The heat was then withdrawn, the water drawn off, and the bottles allowed to cool. "In every case," says Appert, "the exclusion of air is a precaution of the utmost importance to the success of the operation; and in order to deprive alimentary substances of contact with the air, a perfect knowledge of bottles and the vessels to be used, of corks and corking, is requisite." It is interesting at this date, and with our modern views, to read the notions that prevailed in the days of Appert. The alimentary substances were heated to drive the air out of the vessels that contained them. But to get rid of the last trace of air was a practical difficulty, and prolonged boiling was resorted to with the idea that the animal substance was thereby so altered as to render it less disposed to putrefactive change, while, at the same time, it was supposed that any of the oxygen of the air remaining in the closed vessels was thus destroyed. Thus we are told "the heat acts by indisposing the substances from entering into chemical action, and by removing all risk of ill effect from the small portion of air which the vessels may contain; while the rigorous exclusion of the external air contributes to render permanent the state into which the substances have been brought by the temporary application of heat."

Now, though Appert's method has proved of immense practical value, his explanation of it has been proved quite erroneous. For, as has been shown (p. 386), air may be admitted in

abundance to organic solids and fluids without exciting putrefaction, provided the organic impurities have been previously removed from the air by filtration, and substances which have been submitted to the operation of boiling are as eligible sites for the work of decomposition as those that have not been boiled. It is not the oxygen of the air that is the exciter of putrefaction, but the living organisms. It was not the expulsion of air produced by the boiling, for even that was not properly effected, that preserved the food-stuffs, it was the destruction by the heat of the living things; and it was not the continued exclusion of the air in itself, by sealing, &c., that maintained the preserved condition, but the barrier thus set up to the access of a new supply of active organisms. Enormous quantities of all sorts of alimentary substances are now preserved for indefinite periods by methods similar to that of Appert, greatly improved in its details. The substances to be preserved are packed in tins; a small quantity of water is added. The covers are carefully soldered on the tins, and in each cover is made a small pin-hole. The tins are then placed up to a short distance from the covers in "baths" of water, to which chloride of calcium has been added. The addition of the chloride raises the boiling point to between 260° and 270°, and thus ensures a greater degree of heat than could be obtained by water only. The bath is kept boiling for some time till the issue of steam from the pin-holes ensures the expulsion of air from the tins. Solder is then dropped on the pin-hole and the tins thus tightly sealed. They are then completely immersed for some time in the hot bath, and after being removed are placed in chambers kept at the degree of temperature most favourable to putrefaction. There they remain for some time. If decomposition ensues in any of the tins, it is evidenced by the bulging of the sides owing to the pressure of the gases of putrefaction. If the food remains sound, the top and bottom of each tin should be concave, pressed inwards by the atmospheric pressure outside and the diminished pressure, owing to the partial vacuum, within. If the soldering gives way at any part of the tin, or if, in course of transit, by bad usage, and so on, a crack be opened in the casing, or a point of a nail driven in, or if, by the action of weather, damp, &c., the paint coating of the tin having become rubbed off, the metal has been eaten into, air will effect an entrance with a rush, carrying germs of putrefaction with it. Thus a tin apparently sound may, on being opened, reveal putrid contents. Search will likely discover the secret pathway of the enemy. That the process is, however, an eminently satisfactory one, so far as preservation is concerned, is shown by the fact that stores of tinned meats, landed on the beach of Prince Regent's Inlet from the wreck of H.M.S. *Fury* in 1825, were found twenty-four years later in a perfect state of preservation by the captain of H.M.S. *Investigator*, and that in spite of exposure to extremes of weather. The extent of the industry which has been developed, aided by various modifications and improvements in the process, is of a very remarkable character. For the following statistics in reference to the industry I am indebted to the kindness of Messrs. Simpson, Roberts, & Co., of Liverpool and Halifax.

In 1885 21,255,000 pounds weight of tinned meats were imported into the United Kingdom from Australia, the value of which was about £430,000. On the Pacific Coast of North America the tinning of fish, principally salmon, is a large industry, the amount packed in 1884 being 47,294,160 in tins of one pound, and in 1885 the amount was 40,114,320 one-pound tins. Of these one-pound tins from seventeen to nineteen millions are imported into the United Kingdom annually to cheapen our fish supplies.

Messrs. Simpson, Roberts, & Co. also inform me that an average of 50,000 one-pound tins of canned salmon are consumed daily in this country, 35,000 of lobster, and probably 100,000 of beef and mutton. In Australia the industry is conducted at 19 factories, of which 4 are in Queensland, 5 in New South Wales, 4 in Victoria, and 6 in New Zealand, and the work is performed mainly by Scotchmen or men of Scotch descent, to the number of 2500 to 3000 persons. In Canada the Scotch villages on the coasts of Nova Scotia, Cape Breton, and Prince Edward Island furnish the bulk of the fishermen, and packing men, women, and girls. In many fishing villages in Nova Scotia and Cape Breton Gaelic is still found, and in many it prevails. With the Scotch villages are found French communities, which furnish clever-fingered females for the careful and tasteful filling of the lobster cans. In many instances the parish priest conducts the business arrangements of the simple Franco-Canadian peasants, and inspects during the season the conduct and progress of his flock. The value of the industry to the fishing community of Canada and Newfoundland amounts to from £250,000 to

£300,000 annually. So energetically has the fishing been pushed that the supply has rapidly diminished for two or three years past. Six years ago two or three lobsters filled a one-pound can, but in 1885 over five were necessary. Restrictive laws under such circumstances seem absolutely demanded. On the Columbia, Oregon, and neighbouring rivers the salmon fishing is carried on by white men, and the canning by Chinese labour, but in British Columbia to the north both are conducted by whites, though the Chinese are expert, cleanly workers, and more economical. In Scotland large businesses are carried on in Aberdeen, Dundee, and Leith in the preservation of meat, fish, &c.

This canned goods industry has thus, within comparatively recent years, assumed enormous proportions, and has become of vital interest to considerable populations. There can be no doubt, however, that the industry might become even more extended but for the fact that, by the methods employed, the meat is constantly overcooked, and to that extent not so much relished by the people. So far as one can gather all this superheating is for the purpose of expelling the last traces of oxygen not only from the tin but from the tissue itself. Many of the comparatively recent patents have been taken out because of some new modification that would ensure this more completely. Now it is fifty years since scientific investigators showed that the notion that the oxygen of the air was the cause of putrefaction was a delusion, yet this mistaken idea guides the practice of an industry which has practically developed since that time. The scientific facts tend resistlessly to the conclusion that absurdly high temperatures are employed in the canning process, and that the alimentary substances are exposed to them for unnecessarily long periods. I cannot resist the conclusion, from a careful survey of the facts, that if, to the undoubtedly high degree of perfection to which the mechanical portions of the operations of canning have been brought, some acquaintance of recent scientific advances in knowledge and in methods were added, some simple modifications of the process would be found, which would permit of the employment of a much lower degree of temperature, without interfering with the thoroughness of preservation.

Within recent years the agency of cold has been invoked on a very extensive scale for the preservation of food. A patent was taken out by John Lings in 1845 for employing ice in closed chambers to reduce the temperature to the proper degree. If a sufficient degree of cold is obtained the activity of the organisms of putrefaction is arrested, though the organisms are not destroyed. On the restoration of a normal temperature they become as active as ever. Following Ling's patent, others were taken out for obtaining the requisite low temperature by the evaporation of ammonia and ether. The invention of machines for the artificial production of ice gave an impetus to the employment of ice for preserving food for considerable periods. During the winter of 1875–76 large quantities of beef, mutton, and pork were brought from America preserved by ice. An effort made in 1873 to bring meat from Australia, preserved in this way, failed because the supply of ice gave out before the end of the voyage. It seemed as if there was little prospect of a trade in fresh meat being opened up between this country and so distant quarters of the globe as Australia. But in 1879 Mr. J. J. Coleman of Glasgow went out to New York with a Bell-Coleman air refrigerating machine, and proved that food could be preserved for long periods by the agency of air cooled by mechanical means. This Bell-Coleman machine is a remarkable example of the practical working out of advanced scientific theory. Its construction is based on the principles of thermodynamics, that when air is compressed heat is evolved, and that, if this compressed air be then allowed to expand, and be caused, in the act of expansion, to do work, a large amount of heat disappears. The machine, worked by steam, sucks in a certain quantity of air and compresses it to a pressure of 50 to 60 pounds to the inch. The air in the act of compression becomes very hot; it is cooled by the injection of cold water. The cold compressed air is now dried by being passed through a set of horizontal pipes, and is then allowed to expand behind a piston, which it propels in the act of expansion. In the act of doing work the expanding air becomes cooled, "as much as 50, 100, and 200 degrees below freezing point, according to the amount of previous compression." The cooled air is passed into the chamber containing the provisions, and the temperature of the air in the chamber can be kept by the machine at a constant low temperature for any length of time. With such machines no previous packing of the meat is required. The carcasses are cut up into quarters or other convenient sizes, placed in calico bags, and packed in the freezing chamber. Up to the beginning of 1883

about 4000 tons of frozen meat were delivered in Great Britain from Australia and New Zealand, preserved by the cold-air machines. As an example the following may be taken. The sailing ship *Dunedin* left Port Chalmers on the 15th February, 1882, and arrived at London Docks after a passage of 98 days. She brought 4909 carcasses of sheep and 22 pigs, all in excellent preservation, in a chamber kept cold by a Bell-Coleman machine. The sheep had been killed on the estate of the New Zealand and Australian Land Company, and were brought to the ship from a distance of sixty miles. They were hung up in the freezing chamber, and, when frozen hard, were wrapped up in calico bags and packed in layers in the lower chamber of the ship. They realized in London over £4200 more than was necessary to pay all expenses, which was equal to over 3 pence per pound for the mutton. According to the Smithfield Market reports, 27,007 tons of mechanically cooled meat, chiefly beef, arrived from the United States of America in 1884. In 1885 the total quantity of mutton received in this way from the colonies of Australia, New Zealand, and the River Plate was 777,891 carcasses, which weighed 21,930 tons.

Cold preserves meat simply because, at a low temperature, putrefactive and other germs are inert. They are not destroyed, but simply dormant, and when a normal temperature is restored they renew their activity. It has been noticed that frozen meat spoils more quickly after it has been thawed than ordinary meat. This is probably due to the fact that the process of freezing separates out water which formed part of the tissues, and that, on thawing, the water is not taken up again into the substance of the tissues, but remains simply moistening them. The meat being thus in a more moist and soft condition, permits of more rapid development and propagation of organisms. If frozen meat be thawed very slowly, however, the moist condition is not so marked, and the meat will remain longer in good condition.

Recently Mr. Coleman, in conjunction with Prof. M'Kendrick, investigated the question whether an extremely low temperature of 150° below zero or thereby, which can readily be obtained by a Bell-Coleman machine, would not absolutely destroy living organisms. They answer the question in the negative. Micro-organisms submitted even to such a low temperature as that became as energetic as ever when warmth is restored. Had the question been answered in the affirmative, it is easy to see what a new and valuable addition would have been made to food-preserving methods. It would then have been possible to seal up *fresh uncooked* meat in tins, and after a period of exposure to the extremely low temperature, to keep it, as cooked food is now kept, in tins, without any other precaution, for indefinite periods.

SECTION II.—DRINKS.

Water.

The Composition of Water.

The Physical Properties of Water:

- *The Density of Water*—Its Relation to Temperature;
- *Latent Heat and Capacity for Heat of Water;*
- *Water as a Solvent.*

The Constituents of Water:

- *Solid Constituents of Water*—Cause of Hardness in Water, and the Means of Softening Hard Waters;
- *Gases Dissolved in Water.*

Impurities in Water:

- *Organic Impurities;*
- *Gaseous Impurities;*
- *Metallic Impurities*—Lead, &c.

The Various Kinds of Water:

- *Distilled Water*—Its Action on Lead;
- *Rain Water*—Its Constituents Dependent on the Atmosphere through which it falls;
- *Ice and Snow Water;*
- *Well Water*—The Relative Purity of Shallow and Deep Well Water;
- *Spring Water—Artesian Wells;*
- *River Water—Lake Water—Sea Water.*

The Detection of Impurities in Water:

The Detection by Colour, Odour, and Flavour;

Tests for Organic Impurity—Nessler's and the Permanganate Test—How to Employ Them—The Meaning of Albuminoid Ammonia;

The Detection of Lead;

The Microscopic Examination of Water—Living Organisms in Water.

The Purification of Water:

Filtration and Filters for Domestic Use;

The Clarification of Water by Alum, Oak Chips, &c.;

Purification by Condy's Fluid.

Impure Water as a Cause of Disease.

Aerated Waters:

Carbonic Acid Gas—Its Preparation and Properties;

Soda Water—Potash Water—Lithia Water—Lemonade and Gingerade;

Oxygenated Water;

Contamination of Aerated Waters.

Tea, Coffee, Cocoa, Chocolate.

Common Features of Tea, Coffee, &c.:

The Active Principles of Tea, &c.—Thein, Caffein, Theobromin;

The Essential Oil and Astringent Principle of Tea, &c.—Tannin in Tea.

Tea:

Its Characters and Method of Preparation;

The Composition of Tea;

The Value of Tea as a Food-stuff—Constituents of a Cup of Tea;

Adulterations of Tea.

Paraguay Tea or Maté and Bohemian Tea.

Coffee:

The Composition of Coffee;

The Action of Coffee—Constituents of a Cup of Coffee;

Chicory—Coffee Leaves.

Cocoa:

The Preparation of Cocoa—Cocoa-nibs—Chocolate;

The Composition of Cocoa;

The Value of Cocoa as a Food-stuff;

Brazilian Cocoa or Guarana.

Coca or Cuca.

The Kola-nut.

Alcoholic Drinks.

Alcohols:

The Composition of Alcohol—Wood Spirit—Spirit of Wine—Potato Spirit or Fousel Oil;

The Preparation of Alcohol—Malting—Fermentation—Distillation—Rectified Spirit—Absolute Alcohol—Proof Spirit;

Proportion of Alcohol in various Spirits;

Brandy and Whisky;

Rum—Gin—Arrack;

Liqueurs—Absinthe—Curaçoa—Benedictine—Noyeau—Maraschino—Kirschwasser—Chartreuse;

The Effects of Alcohol on the Body—Is Alcohol a Food?—Its Value in Disease.

Wines from the Grape:

The Preparation of Wine—Dry Wine and Sweet Wine;

The Composition of Wine—Plastering of Wines;

The Use of Wines;

The Adulteration of Wines.

Wines from Fruits other than the Grape:

Cider and Perry;

Gooseberry Wine, &c.

Beer and Malt Liquors:

The Preparation and Composition of Beer and Stout—Lager Bier—Weiss Bier—Ginger and Treacle Beer.

The Nutritive Value of Malt Liquors.

WATER.

Composition of Water.—Water, up to the year 1782, was considered a simple substance, but about that year the Honourable Henry Cavendish showed it to be a compound body, formed of the union of two gases, oxygen and hydrogen. He showed that when these two

gases, mixed in a certain proportion, were caused to enter into chemical union by the agency of the electric spark, drops of moisture were formed on the inner surface of the vessel. The French chemist, Lavoisier, confirmed this observation by a reverse process, namely, by splitting up water into the two elements of which it is formed. When an electric current is passed through water contained in a tube, such as is shown in Fig. 257, the water is decomposed into its elements, which appear as bubbles of gas at the terminals or poles of the wire. One gas is given off at the positive pole, namely, oxygen,

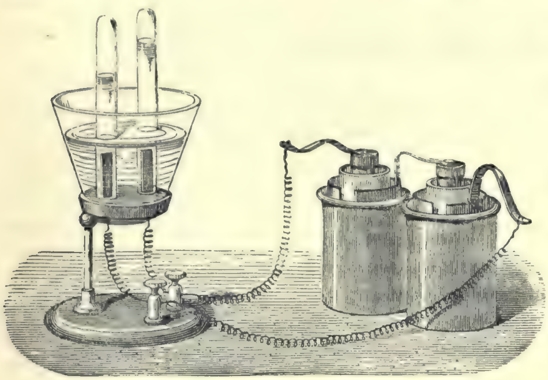


Fig. 257.—Apparatus for Decomposition of Water.

and collects in that end of the tube, the other gas, hydrogen, is given off at the negative pole, and is collected in that limb of the tube. If this experiment be performed, it will be noticed that the gas which collects on the side of the negative pole is twice as much as that which collects on the other side. Moreover, if an accurate experiment be made as to the union of the two gases in the formation of water, it is always found that twice the bulk or volume of the hydrogen is required to combine with a given volume of oxygen. If more than twice the volume of hydrogen is supplied when the union is effected, the excess of hydrogen will be found uncombined. If less than twice has been supplied, some of the oxygen will be found uncombined. Always twice the volume of hydrogen, neither more nor less, unites with a given volume of oxygen to form water, and thus the chemical formula representing water comes to be H_2O, indicating the facts that have been stated. But while two *volumes* of hydrogen unite with one of oxygen, the quantity of hydrogen is not twice the *weight* of the oxygen. For if a volume of hydrogen be taken, say a large enough bulk of it to weigh 1 lb., if an equal volume of oxygen were weighed it would be found equal to 16 lbs.; that is, oxygen is sixteen times heavier than hydrogen. Two pounds of hydrogen then unite with sixteen of oxygen, or the proportion by *weight* is 1 to 8. If then 1 pound weight of hydrogen were caused to unite with 8 pounds weight of oxygen, the result would be 9 lbs. weight of pure water. Such a thing as absolutely pure water is not, however, known. For even when pure oxygen and pure hydrogen have thus united to form water, the contact of the water with the sides of the vessel, glass, iron, &c., robs it of its absolute purity, for it would derive some minute trace of earthy matter from its touch. Distilled water contains some traces of earthy matter. Moreover, water has not only the power of dissolving solid substances, but it also dissolves gases. So that water exposed to the atmosphere takes up into solution appreciable quantities of the oxygen and nitrogen, which, in mechanical mixture, form the common air, and also of other gases, such as carbonic acid gas, which is always present in the atmosphere. Water, as we know it, always contains gases in solution, and contains also solid matters in solution, the nature and quantity being dependent upon the channel along which the water has flowed, if it be taken from a river, or the soil through which it has passed, if it be from a spring, and so on. "Pure water" is, therefore, a phrase used merely relatively, and is applied to water which possesses only such natural ingredients, in small amounts.

Physical Properties of Water.—Within a certain range of temperature, at the ordinary pressure of the atmosphere, water remains liquid. The range of temperature is, on the Fahrenheit scale, between 32° and 212°; at the former the water becomes solid, at the latter it becomes converted into vapour.

Density.—Connected with these two transformations are some extremely remarkable facts. All bodies expand and become less dense on heating, and contract, becoming more dense, on cooling. Water follows this rule only to a certain extent. On cooling its density gradually increases till a temperature is reached of 39½° Fahr. That is to say, up to this point, in a pond or lake, let us say, in cold weather, the water will undergo a process of mixing. As the water on the surface is cooled down by contact with the cold atmosphere, it becomes more dense, sinks, and allows warmer water from below to rise to

the surface, which in turn becomes cooled, sinks, and so on. Now suppose the cold were intense and long enough continued, this process might go on till the whole mass of water in the deepest lake, or sea for that matter, were reduced to the freezing point, so that the lake or sea would become frozen to the bottom, and all fish would perish. The remarkable fact, however, is that at the temperature of 39½° F., water has it maximum density. If the temperature falls below that point the water ceases to follow the rule and begins to expand, and continues to expand till the freezing point is reached. A vessel filled to the point of overflow with water at 39½° will immediately begin to run over, if the water is further cooled, because of the expansion. It is this that causes water-pipes to burst in time of frost. The effect of this on lakes, &c., is that as soon as the water on the surface becomes cold enough to be on the point of forming ice, it is of less density than the water below, and remains upon the surface. It is also a bad conductor of heat, and so it serves as a protection between the freezing atmosphere and the warmer water beneath, preventing the mass of water freezing throughout.

Latent Heat and Capacity for Heat.—A second remarkable fact is that in the transformation of water from the liquid to the solid state, a large amount of heat is liberated from the water, and when the solid ice is retransformed into liquid water, a disappearance of heat takes place to the same extent. This may be easily understood by a simple experiment. If ice be placed in water in a pot, and set on the fire, it will, of course, melt. If the temperature of the mixture be taken it is 32° F., and when the pot has been on the fire sufficiently long to cause the ice to be nearly all melted, if the temperature be again taken, it is still 32° F. A large amount of heat has disappeared, or has become "latent," as the phrase is, in the act of melting the ice. The quantity of heat which thus disappears or becomes latent in melting the ice would be sufficient to raise the temperature of 1 lb. of water from freezing point up to 174° F.

A similar thing happens when at the boiling point water becomes converted into vapour. The temperature of boiling water and of the vapour given off is the same, and yet a large amount of heat disappears in the transformation of the liquid to the gaseous condition. The heat which thus becomes latent is called the latent heat of vapour, and is so great that the heat which disappears in converting 1 lb. of water into vapour would raise the temperature of over 5¼ lbs. of water from freezing to the boiling point. In other words, 1 lb. weight of the vapour of water at the boiling point, if mixed with 5¼ lbs. of water at the freezing point, would make the water boil. It is this fact that makes it possible for one to boil water in a capsule of paper. So long as there remains any water in the paper it will not burn, for the temperature cannot rise above 212° till all the water has been converted into vapour, and this temperature is not sufficient to set fire to the paper. It is the same fact that makes steam so valuable an agent for heating purposes. For in passing back again from the condition of vapour to that of water, this enormous quantity of heat is liberated, and may be used to heat the atmosphere. In passing from the liquid to the gaseous state water expands enormously; the vapour given off from one pound of water will occupy a space 1600 times greater than that of the water; hence arises the energy of steam-engines.

It may be noted here that the vapour of water is quite colourless. It is only when the vapour passes into a colder atmosphere and begins to condense that it becomes visible as steam, or as fog, cloud, &c.

It is, moreover, the operation of the same fact in nature which prevents sudden changes likely to be destructive alike to the life of plants, animals, and man. Just as the passing off of the water, boiling in a paper-bag over a flame, into steam saves the paper from destruction, so is the earth saved from bursting into fervent heat under the influence of a hot sun by the evaporation of water from its surface, and from river, lake, and ocean. Even so is the human body saved from destruction by fire, by the fire of the combustion process going on within itself. For it has been estimated that the heat given off within the body by the oxidation of food is sufficient in 24 hours to raise the whole body to the boiling point. The evaporation of sweat from the body causes the disappearance of an enormous quantity of heat, and thus keeps the temperature at a normal level (see p. 309); on the other hand, if the passage of ice to water did not involve a large absorption of heat, a few hours of a hot sun would convert masses of snow on mountain ranges, or ice-glaciers, into torrents carrying destruction to the valleys. But the physical facts that have been stated show how the inevitable and unceasing operations of nature, as they apply even to such an apparently simple

substance as water, substitute gradual changes for sudden reversals, and combine for the comfort and continuance of the living creation. A kindred fact to that of the latent heat of water is what is called the capacity for heat of water. Suppose a quantity of lead to be placed in a pan over a fire, and the same weight of water placed in a similar pan over the same fire, the lead will become hot long before the water, because the lead has much less capacity for heat than water. This is represented in figures by saying that the capacity of water for heat in comparison with lead is as a 1000 compared with 31. To put it in another way, one could heat 32 pounds of lead to a certain degree as quickly as 1 pound of water to the same degree. Our seas, lakes, rivers, &c., become warm more slowly than would similar masses of any other substance, and they cool also more slowly, and in this way also they are natural opponents of sudden change, and are important agents in securing gradual changes of season, and in tempering alike the fierceness of summer and the rigour of winter.

The boiling point of water is 212° F. at the atmospheric pressure represented by 30 inches of mercury. If the pressure falls, as it does when one ascends in the atmosphere, water will boil at a lower temperature. Thus when the pressure falls to nearly 28 inches, water will boil at 209° F. On the top of Ben Nevis, in Scotland, 4406 feet above sea-level, the boiling point is reduced to 203°, equal to a barometric pressure of a fraction above 25 inches. If the pressure be increased, as it is if one descends a pit, the temperature of boiling rises. Moreover, the pressure of dissolved salts in water raises the boiling point. Thus common salt, to the amount of 7·7 per cent, will raise the temperature nearly 2°.

Water as a Solvent.—Water is one of the most efficient of solvents, dissolving solids, liquids, and gases, though in very different proportions: thus 1 lb. weight of cold water will dissolve 3 lbs. of cane-sugar, but the same quantity of cold water will dissolve not much more than ⅓d lb. of common salt. Hot water usually dissolves substances more readily than cold, though this is not always so. For water at the point of freezing will dissolve twice as much lime as water at the boiling point. Gases are dissolved in water very readily, some, however, much more readily than others: carbonic acid gas, the gas which gives the briskness to aerated waters, ammonia, and sulphurous acid easily, and oxygen and nitrogen with less ease. The quantity of gas that water can hold in solution depends upon the temperature and upon the pressure of the atmosphere. We all know, for example, that in hot weather aerated waters, &c., very readily burst the bottles in which they are confined, or blow out the corks. This is because, under the influence of the heat, the water has been compelled to give off the gas it held in solution at a lower temperature, and the pressure of liberated gas has become too great for the bottle. This is the reason for iced champagne. The placing of the champagne bottle among ice causes it to dissolve much of the gas free in the bottle, but imprisoned by the wired cork, and when the cold champagne is taken into the warm mouth, the gas is rapidly liberated, producing the sharp pleasant sensation. It is the presence of ordinary air dissolved in water and of carbonic acid, that gives to it its pleasant flavour. If the water be boiled the gas is driven off, and the water becomes, in consequence, mawkish and insipid. If suspicious water has been boiled for safety, the pleasant taste may be restored by shaking it up in a large vessel, and thus causing it to dissolve more air. These facts regarding the physical and some of the chemical characters of water have, perhaps, no very direct bearing on the subject of which this section treats, but they are of extreme interest, and not so widely known as they ought to be.

We must now consider some of the properties of water of more direct relationship to the point of view from which, in this section, we must regard it.

Constituents of Water.—Water, we have said, always contains some dissolved substances, picked up as it passes through the atmosphere or filters through the soil, on the quantity of which depends the estimate one forms of the value of the water for drinking and for other domestic purposes. These constituents are of two chief kinds, inorganic, derived, that is, from the lifeless world of matter, such as common salt, lime, &c. &c., and organic, derived from animal and vegetable matter.

The solid constituents of water vary within very wide limits. The following table shows the total saline material present per gallon in a variety of waters:—

	Grains per gallon.
Loch Katrine supplying Glasgow	2
Grasmere	2·92
Rydal	3·11
River Dee supplying Aberdeen	4
River Tay supplying Perth	5
Water supplied to Liverpool	5
Claremont water	5·7

	Grains per gallon.
Farnham in Surrey	7·25
Clyde	9·19
Rhone	9·112
Nile	10·9
Rhine	16·247
Seine	17·84
Thames supplying London	20
Spring water	40–60
Jordan	75
Sea water, Shores of Baltic	1100
,, German Ocean	2380
,, Open Atlantic	2450
,, Mediterranean	2870
,, Dead Sea	17,200

Of these dissolved solids, the commonest is carbonate of lime or chalk. Another compound of lime often present is gypsum, or sulphate of lime. It is these substances, along with salts of magnesia, the carbonate and sulphate, which occur also very commonly, though in much smaller proportion, that give to water what is called **hardness.** Chalk is not very soluble in pure water, but it is always more easily dissolved in water containing carbonic acid gas, which natural water always does. If by any means the carbonic acid be driven off, the water cannot contain the lime in solution to the same extent, and thus some of it is precipitated in a solid form. Boiling thus expels the gas, and it is carbonate of lime, thus precipitated, that forms the crust so common in boilers. If a great quantity of lime be present this water may become milky by the precipitation. Water flowing among hard granitic mountains contains a small quantity of such saline material, a small fraction of a grain per gallon, while in well water, particularly in chalky districts, the quantity may rise to over 20 grains per gallon. Thus, what is said to be the purest of waters is that of the Loka, in the north of Sweden, which flows over insoluble granite rocks, and contains only $\frac{1}{10}$th of a grain per gallon of solid matter. In Bala Lake, North Wales, there is less than $\frac{1}{4}$ grain of lime and magnesia salts per gallon. Loch Katrine water is exceedingly soft, containing only a little over $\frac{1}{2}$ grain of lime per gallon, and $\frac{1}{10}$th of magnesia per gallon. The waters of the various London Water Companies contain 8 or more grains of lime per gallon, and from $\frac{3}{10}$th to $\frac{8}{10}$th grain magnesia, and are, therefore, hard waters. Deep well waters are usually hard waters, containing a higher percentage of these ingredients than either river or lake water. In mine waters the quantity is still greater. Such waters are not well fitted for domestic purposes, cleansing operations being performed with difficulty. Nor are they as a rule agreeable to the taste, being somewhat harsh, though they are commonly bright and sparkling. The lime causes soap to curdle, and a lather cannot be formed till sufficient soap has been used to combine with the excess of lime, so as to render the water soft. Thus they are always extravagant in the consumption of soap. Of all ordinary waters, rain water contains least of such saline substances, therefore it is so soft, and desired in districts where the water, supplied for domestic purposes, is hard. The curdling of soap by hard water is made use of as a test of the degree of hardness. A solution of soap is used and added to a definite quantity of the water, till a lather be formed and remains for five minutes. The hardness is then expressed in degrees. Thus, water, which requires ·012 of a pound of best hard soap to 10 gallons before a lather will remain, is water of 1° of hardness.

How to soften hard water becomes, then, a question of some importance. One method, already explained, is by boiling the water. A second process is that of Dr. Clark, of Aberdeen. His process consists in the addition of quicklime to the hard water, 1 ounce of quicklime to 1000 gallons of water for each degree of hardness. This may seem a strange way of getting rid of the hardness, by adding more of the very agent which one desires to get rid of. The explanation is that the quicklime forms with the carbonic acid a fresh supply of carbonate of lime. The carbonic acid being thus removed, this carbonate of lime is precipitated, and with it the carbonate of lime originally present, and kept in solution by the free carbonic acid gas. The carbonates are allowed to subside and the water run off. This method is employed by manufacturers using enormous quantities of water, but it is not possible for householders. If the hardness is caused by sulphates of lime or magnesia, boiling, &c., will not remove it. The addition of common washing soda, till the water seems to appear milky, will, in this case, soften it, because the sulphates are converted into carbonates by the soda, and are precipitated. Water so softened must not, of course, be used for drinking or cooking purposes.

There is an idea that very soft waters, such as that of Loch Katrine in Scotland, are not so wholesome, because of the absence of lime salts, as others which contain them in more abundance. The latter have been supposed to be more useful, in the case of children, for

example, for the growth of bone and so on. There does not seem to be any substantial ground for such an idea. When one considers the quantity of water drunk per day, one can see that a very insignificant amount of lime could be introduced into the body in this way, and lime salts are better supplied in the ordinary way of food. The addition of lime water to milk or drinking water, for such purposes is, the author believes, a serious mistake, as the lime is apt to be precipitated in the bowels, and to interfere in other ways with the due process of digestion.

Common salt, or chloride of sodium, also is found, as a rule, in ordinary water, though in very small quantities, 1 or 2 grains per gallon. It is the presence of this small quantity, however, that causes the milkiness to appear, if a drop or two of solution of nitrate of silver (lunar caustic) be added to the water, the cause of the milkiness, for example, in the washing of photographic prints. A large quantity of this substance in water, unless it had been from near the sea-shore or from a well in the neighbourhood of deposits of salts, would make one suspicious of admixture of sewage, which invariably contains common salt in solution. Sea water is, of course, rich in common salt, containing over 2000 grains per gallon. The Dead Sea contains nearly 8500, while from Elton Lake, in Russia, two hundred thousand tons of salt are annually obtained.

Salts of potassium are also found in ordinary water in minute quantity, and traces of iron. Mineral waters contain various metals, but these will be mentioned in the paragraphs devoted to such waters.

Besides these substances, which are wholly derived (the exception about common salt having been noted) from the inorganic world, there are other solid substances of a saline nature, derived directly or indirectly from organic bodies, and demanding very special heed. These substances are nitrates and nitrites, compounds of nitrogen with sodium, potassium, or calcium, as nitrate of soda, nitrate of potash, or nitrate of lime. The nitrogen of these compounds is derived from animal or vegetable substances. The presence of such salts in the water indicates, that at one time or other, animal or vegetable matter gained entrance to the water, it may have been in the form of sewage, and that, by a process of decomposition, the organic matter has been broken down and resolved into inorganic substances. This process is performed by the agency of the oxygen dissolved in the water and derived from the atmosphere. The organic substance, in fact, undergoes a species of oxidation, of burning, by which its organic form is destroyed. Now, the presence of nitrates or nitrites is not in itself injurious. They are harmless, provided they do not exist in excessive quantities. The presence, however, of the decaying animal and vegetable matter itself would be injurious, and, but for the process of oxidation, water to which it had gained access would always be threatening to health. The presence of nitrates and nitrites, therefore, is indication of previous contamination of the water, though it does not necessarily imply unwholesomeness of the water. In wholesome water no more than traces of these substances should be present, not more than 0·35 grains in 100,000, according to Hassall.

Gases dissolved in Water.—Gases are present in water in solution. The chief gases are oxygen and nitrogen, obtained from the atmosphere, but oxygen in greater proportion than is found in the air, because water dissolves it more readily than nitrogen. "Twenty-five gallons of water will contain about five pints of these gases," consisting of rather less than two of oxygen and rather more than three of nitrogen (Attfield). Carbonic acid gas is present, usually in considerable quantity; thus twenty-five gallons of water may contain one or even two gallons of dissolved carbonic acid gas, according to circumstances, for carbonic acid gas is very readily soluble in water. Carbonic acid gas is also a product of the oxidation of organic matters present in the water. Just as the nitrogen unites with oxygen and bases, such as sodium, to form nitrites or nitrates, so the carbon of the organized body unites with the oxygen in the water, the atmosphere being an ever-present store whence the water may derive fresh supplies. If carbonic acid gas is an indication of organic material having been present in the water, it is also an indication that nature's purifying process of combustion has been going on, and that the possibly hurtful organized body has been reduced to harmless simplicity. The presence of these dissolved gases gives to water a pleasant sharpness. Without them water would be tasteless and insipid, as water always is which has been boiled, because the heat has expelled the dissolved gases.

Impurities in Water.—**Organic.**—The chief impurity in water is organic matter, which may be present in the water in suspension merely, or in solution. This organic matter may be derived merely from dead and decaying vegetable struc-

tures, washed into the water of a stream, for example, by the rain, or from dead animal matter also, undergoing gradual decay in the fields and ditches, or in the stream itself, or it may be derived from human excreta and the refuse of human habitations, owing to the opening of sewers into the stream, or owing to the trickling of the liquid from a dungheap, for example, finding its way into a well. Of all sources of pollution, the last is the most serious. Now, the nature of the impurities thus cast into water will be readily understood. To take one illustration, urine contains in solution (see p. 292) chiefly urea, a nitrogenous body, the product of the oxidation of albuminous food-stuffs in the body, uric acid, also a nitrogenous body, common salt, phosphates of soda, and other compounds of phosphoric acid, sulphates, &c. Now, if sewage is gaining access to a water supply to any extent, common salt, phosphates, and sulphates, will be found in the water in greater quantity than is usual in ordinary water, derived from the urine, and the unusual quantity of these inorganic, and in themselves harmless, constituents would raise suspicions in an analyst's mind as to the purity of the water. Further, he will be able to detect the presence of a substance containing nitrogen, derived from the urea and uric acid. If he can determine in what form the nitrogen is present, he will obtain a good idea of its source. Everyone knows that if urine stands for a time, it decomposes, becomes muddy, and gives off an offensive ammoniacal smell. This is because, under the influence of atmospheric organisms, the urea becomes converted into carbonate of ammonia. All the urea might thus become transformed, and be no longer found as such; but the fact that an organic body had been present would be signified by the detection of the ammonia, which is formed of the nitrogen formerly existing as urea, and originally derived from albuminous food. With the lapse of more time, further changes would occur, still further altering the form in which the nitrogen existed; these changes being due, as already noted, to oxidation process, the tendency of all the change being to break down hurtful organic bodies into harmless and simple inorganic substances. Albuminous substances themselves gain access to water, and may be detected by the chemist as such, but they undergo in course of time the same transforming process by the agency of the dissolved oxygen of the water. Thus in searching for impurities in water, the chemist tests for albuminoid substances themselves. If they exist beyond the barest trace, that implies that the water is contaminated with material which nature has not yet had time to reduce to simple and harmless forms. Such water is not fitted for domestic purposes, unless purified by some means, and stands, therefore, condemned. Should, however, his tests fail to find such organized material he tests for ammonia, for nitrites, for nitrates, in short, for the substances which would result from the presence of organic impurity, if there had been time for oxidation to occur. If these are found, in any amount, the fact that at some part of its course the stream is contaminated is established, although before it reached the place where the water was taken for analysis nature had had time to effect her purifying processes.

Now, the mere presence of albuminoid material or of its oxidized products does not necessarily render water impure. There is no manner of doubt that such polluted water is continually being used for domestic and drinking purposes, and without harm often resulting. It is not even the quantity of such impurity that determines the unwholesomeness of the water, for one well may be largely contaminated with sewage, and may be consumed without doing any perceptible injury; another, in its neighbourhood, may be so slightly contaminated, that the detection of any impurity in it is a matter of difficulty, and yet it may bring disaster to every household using it. It is the exact nature of the organic pollution that makes the difference, a difference which may be absolutely undetectible by the most delicate tests, and yet may be appalling in its results. Take an illustration: a farm possesses a well, in the immediate neighbourhood of which the dungheap is foolishly permitted to lie. All the waste water and excreta from the farmhouse, all the manure from the stables and byre, &c., are thrown on this heap. The watery portions from the heap filter through the ground and gain access to the well. The water of the well is used by the people of the farm for their own domestic purposes, for washing milk-cans, and so on. This state of things may last for years and no one be apparently any the worse of the polluted state of the well. But one of the farm hands takes typhoid fever and is nursed at the farm. The excreta from the patient are also thrown on the heap, and filter into the well. The pollution of the well is not altered in *quantity*, it is no more than it has been for years, but it is altered in *character*. A peculiar character has been imparted to it, marked by

an outbreak of typhoid fever among those to whom the milk from the farm is distributed, because the milk has become in turn polluted by the water, used to wash the milk vessels or to mix with the milk. No chemist could detect by any test whatever the poisonous character that had been imparted to the well. He could determine that it contained organic impurity, but he could do no less, perhaps only a brief month before, when the water was apparently harmless. Perhaps if things are simply allowed to go on, as they often are, the patient dies or recovers, no more typhoid excreta are thrown upon the heap, though the excreta of the dwelling are consigned to it as before, water still filters into the well as before, and pollutes it as much (in quantity) as before, but its death-dealing power disappears and it becomes again harmless. Still to chemical analysis it yields no indication of difference. When it is impossible to distinguish between an organic impurity which is harmless, and one which is harmful, there is only one means of obtaining safety, and that is to declare as unfit for use any water which contains organic impurity to any appreciable extent, and entirely to condemn any water in which even a slight trace of organic impurity appears to be due to sewage pollution.

Gaseous Impurities in Water.—Ammonia, being derived from organic bodies, has been already referred to as an impurity. Sulphuretted hydrogen is also derived from the oxidation of organic substances. Sulphurous acid gas and various other vapours may be derived from the atmosphere, and are frequently found in rain water. Their presence depends on the kind of chemical works, manufactories, &c., in the neighbourhood. Carburetted hydrogen is another gaseous impurity sometimes found.

Metallic Impurities in Water.—Water is sometimes contaminated with lead, zinc, copper, iron, and arsenic. These are generally derived from cisterns or pipes for either storage or distribution of water. Rain water may contain zinc or lead from zinc lining the roof from which the water was collected. Arsenic may be derived from the atmosphere. The common contamination, however, is from lead. The purest water, that which contains least saline ingredients, and is consequently very soft water, is that which most readily acts on the lead piping. Water which contains organic matter, nitrite of ammonia, and chlorides, also readily becomes impregnated with lead. On the other hand, waters rich in carbonic acid gas and hard waters themselves afford the best protection, for the carbonic acid forms with the lead an insoluble carbonate, and this coating the metallic surface prevents further action on the metal. In the same way carbonates, phosphates, and other salts form a coating. It appears, however, that an excess of carbonic acid will redissolve some of the carbonate of lead, and thus waters, aerated waters, for example, highly charged with carbonic acid, are open to metallic contamination. Acids derived from organic substances, such as fruits, vegetables, beer, &c., act strongly upon lead, and water containing such impurity readily acquires also metallic contamination. The result of drinking water containing lead to any amount is symptoms of lead-poisoning, of which one of the earlier is lead colic, and one of the later is lead paralysis. Cases of lead-poisoning have arisen, according to Dr. Angus Smith, from as little as $\frac{1}{100}$th grain per gallon; but some persons are more susceptible to the action than others. According to Parkes any quantity over $\frac{1}{20}$th grain per gallon should be considered dangerous. It may be noted that water in cisterns may acquire lead from a leaden cover, with which the water does not make contact. Vapour of water spontaneously rising from the cistern condenses upon the lid. It is thus distilled water, acting most readily upon the lead, of which it dissolves some portion, and the drops falling back into the cistern carry lead in solution with them. The cistern should, therefore, be provided with a wooden or slate cover.

The Various Kinds of Water differ in the quantity and kinds of their constituents.

Distilled Water is comparatively pure. It is entirely free of mineral constituents such as chlorides, carbonates, sulphates, &c. It is prepared by placing the water in a vessel or boiler, fitted with a tight lid, from the centre of which a metal tube arises. The tube is prolonged and coiled to economize space. The heat applied to the boiler raises the water in vapour, which as it passes through the tube, or still, as it is called, condenses to steam, and then to water, which issues in drops and is caught in a receiver. To quicken the process the tube is surrounded by a tub through which cold water flows, thus quickly condensing the steam. From the water in the boiler the gases quickly pass off and may be allowed to escape before the water is collected in the receiver. If, however, the water employed contains ammonia in solution, or as carbonate or nitrite, it will be given off and be readily dissolved again by the condensed steam; so that unless proper precautions are taken, the distilled water may not be free of ammonia.

The water may also contain other impurities, readily given off as vapour to contaminate the distilled water. It is necessary, therefore, to employ water as free from organic impurity as possible. The first portion of the distillate ought always to be thrown away in any case. Further, the process should not be carried on till all the water in the boiler is driven off, lest some of the residue be blown over into the condenser. Distilled water is largely produced from sea water in sea-going vessels, thus getting rid of the difficulty of storage, and of the risk of the stored water undergoing changes and suffering harm from the tanks in which it is kept.

Distilled water is not at all palatable, owing to the absence of dissolved gas. This is overcome by re-aerating the water, mixing it again with air, for which purpose special apparatus has been devised, one in common use being that of Dr. Normandy.

Distilled water, containing as it does no solids, is peculiarly apt to dissolve minute quantities of the material of the pipes through which it passes. Lead pipes are particularly liable to attack, and lead-poisoning has frequently been produced in this way, not only from pipes themselves, but from the joints of the distilling apparatus. The boiler should be of earthenware, iron, or copper, the pipes of earthenware or tin, and the condenser of the same, copper pipes and condensers being avoided. Zinc pipes should also be avoided.

Rain Water, if proper arrangements exist for its collection and storage, ought to be a very pure and soft kind of water. It never can be absolutely pure, for in its descent through the atmosphere it will dissolve gases of the atmosphere, as well as solid matters floating in the air, and it will also wash down with it floating matter which it may yet be unable to dissolve. What the nature of the dissolved and suspended matter is will depend, accordingly, upon the nature of the atmosphere through which it falls, and the constituents of the rain water will afford an indirect method of determining the nature of the atmosphere. In country places, devoid of manufactories or large collections of houses, it will be purest; and in manufacturing districts and in large towns it contains considerable impurity, both of an inorganic and organic kind. Nitrogen and oxygen gases it will contain in solution, and also carbonic acid gas, but in very small proportion compared with well waters, for the atmosphere contains only 4 parts of this gas in 10,000. Sulphurous acid, hydrochloric acid, nitric acid, ammonia (free and in combination), &c., will also be in the atmosphere, derived from chemical and other works. Organic impurity, swept down from the air, is also present in larger or smaller quantity, derived from animal emanations. Thus Dr. Angus Smith states the amount of free ammonia and albuminoid ammonia found in the rain water of various localities, of which a few samples are given:—

In rain obtained at Valentia, Ireland, there were	0·180	parts of ammonia	per	1,000,000.
,, ,, at west coast of Scotland	,,	0·484	,,	,,	,,
,, ,, ,, ,, England	,,	1·900	,,	,,	,,
,, ,, in London	,,	3·450	,,	,,	,,
,, ,, ,, Manchester	,,	6·469	,,	,,	,,
,, ,, ,, Glasgow	,,	9·100	,,	,,	,,

The albuminoid ammonia in rain water varied from 0·034 parts per 1,000,000 in Valentia to 0·105 on the west coast of Scotland, 0·251 in Manchester, and 0·3 in Glasgow. Of inorganic constituents sulphates amounted to 0·1911 grains per gallon rain water at Valentia, 2·9 in Manchester, and 4·9 in Glasgow. The contrast between the state of the atmosphere in Valentia and in Glasgow is very strikingly shown in such figures as these. Near the sea, salt is acquired from the atmosphere. In the country, 2 grains per gallon is about the average quantity of all the constituents of rain water. To this, however, must be added varying quantities dependent upon the mode of collection. If it has come into contact with limestone walls, roofs, &c., chalky substances will have been acquired; if with tile roofs, vegetable matter is likely to be present, because of the low forms of vegetable life usually found on such roofs; if it has been collected on a zinc-lined roof, lead contamination may be present. Slate roofs are least apt to yield any notable addition to its constituents. Further, care must be taken with the pipes through which it passes, as its freedom from constituents makes it readily attack lead, and with the cisterns in which it is stored —slate cisterns being the best, or cisterns made of brickwork, set in cement and plastered over with it. The gutters along which the water flows to the tank should be cleaned at regular intervals. It is advisable not to allow the first portion collected after dry weather to be run into the cistern; and for drinking purposes it

should be filtered, through three or four feet of clean gravel, and then through one or two feet of charcoal. This not only removes impurities, but also aerates the water. Rain water is highly desirable for domestic purposes because of its softness, and is, when the precautions indicated have been followed, less likely to be contaminated than other kinds, and most wholesome and palatable.

Ice Water is comparatively pure. In the process of freezing the gaseous and saline ingredients are separated out, so that ice formed of salt water is yet free of the salt and very pure. Water obtained from melted ice is flat and insipid because of the absence of gas.

Snow Water is for a similar reason very pure. There is a popular opinion that water obtained from melted snow is unwholesome. There is no ground for this view, for when melted it is as good for quenching thirst and as wholesome as other kinds of water, though the absence of gas renders it less palatable.

Well Water is rain water which has passed into the soil, and filtered its way through it till it reaches the level at which the ground is saturated. The soil acts as a sponge, absorbing and retaining within its interstices water, more or less according to the nature of the soil. In its course the water dissolves much of the earthy constituents it meets with, and the exact nature of its mineral constituents will consequently depend on the strata through which it passes. Usually well waters are hard waters, because their prolonged passage through the soil has permitted them to dissolve much calcareous and other material they have come into contact with. Thus 15 to 25 grains per gallon is a common amount of solid matter for deep wells in the chalk, which yield as a rule wholesome and pleasant water. Now, in its course through the soil the water will carry with it much organic material, from decaying vegetable or animal matter on the surface, perhaps from manure spread over the surface, and so on. If the water percolates far enough through the soil this organic matter is all destroyed, oxidized, burnt, in its passage. It undergoes chemical union with the oxygen contained in the ground air, in the pores of the soil, and ceases to be organic substance as such. The products of this combustion, in the form of nitrates, are in the water, but are harmless. If this be understood, it explains at once the difference between the water of shallow and of deep wells. The former collect water which has passed through only a few feet of soil, sufficient perhaps to deprive it of all muddy appearance, so that it looks clear enough, but not sufficient for the oxidation changes to be completed. Surface wells are always to be regarded with suspicion, especially if in the neighbourhood of habitations, whether for man or beast, as it is almost certain some of the surface drainage will gain access to it. Deep wells may be polluted in the same way, the water which rises up in the depths of the well being perfectly pure, but the manner of building the well permitting surface water to soak into it from above. For the purpose of preventing this, if the well is built of brick a good facing of cement is most useful. If the well has been polluted, it is difficult to get rid of the contamination, even after all further access of impurity has been prevented. A considerable time must be allowed to elapse, and the natural process of purification may be aided by removing as much of the water as possible on several occasions. Deep well waters are usually sparkling and pleasant to taste from the abundance of carbonic acid they contain. This carbonic acid is produced as the water finds its way through the soil, because the carbon of the organic material, undergoing oxidation, unites with the oxygen of the air in the soil, and carbonic acid gas is formed. Deep well water is usually brought to the surface by pumping; and pump water and deep well water signify commonly the same thing.

Spring Water is the same in its nature as ordinary deep well water. The fact that the water *springs* is due entirely to mechanical conditions. The water issuing from a spring at the surface, whether the surface be a natural one or one artificially produced, as, for example, in digging a well when a spring is come upon, has its gathering ground at a higher level than its point of issue. But it has been prevented sooner reaching the surface by impervious strata of earth; and when at last it is able to flow up to the surface, it comes with a rush more or less marked according to the difference of level between its point of outflow and its gathering ground. If, at the point where it flows out, one were to build a wall round it, it would rise in the cylinder thus formed, until it reached a height equal to that of its gathering ground, wherever and at whatever distance that might be. One would then have a well, only above instead of below the surface level. If, through long-continued drought, the level of water in the gathering ground fell, the height of the column of water in the tower would fall also; and if, by long-continued rains, the level of the former rose, that of the latter would rise also.

This is the explanation of intermittent springs. The level of water in their gathering ground is not always so high as to keep a continual outflow at the spring. It is only after heavy rains at the high ground that the spring flows out, and when, after the rains have ceased, the level of the ground water at the high land falls, the overflow at the spring ceases.

Artesian Wells (Fig. 258) are bores passing often great distances into the ground, through impervious strata, and tapping streams, flowing through the lower pervious layers, whose gathering grounds are much higher than the surface of the bore. When the stream is thus tapped the water rises in the bore and overflows on the surface because of the difference in level. This is represented in the figure, where D taps water in the pervious stratum C C kept from reaching the surface A by the impervious stratum B B.

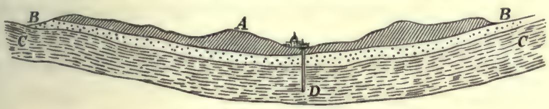


Fig. 258.—Artesian Well.

One of the earliest of such wells was in the French village of Artois, hence the term Artesian. The well at Grenelle, Paris, is 1800 feet deep, and contains a large quantity of carbonates of sodium and potassium.

River Water is rain water collected from the uplands, with additions perhaps from springs, and, as it flows through the lowlands, with additions of surface water from fields, waste and sewage from farms, villages, &c., on its banks. Its quality will be very different near its source from what it is near the sea. In the high lands it will contain ingredients washed down into it from the hillside, and gained as it passes through glens and ravines. But such water is likely to be extremely wholesome and pleasant. Any organic substance in it is not likely to be productive of harm, being derived from natural sources; and, besides, in the course of the water downwards, the combustion of the organic material occurs; and as it is broken up into spray and mixed with air in tumbling over cascades and dashing into foam in its irregular broken channel, it is undergoing a rapid process of purification. But, as the river flows through cultivated and highly-manured fields, and receives a large quantity of impurity from farms, &c., it becomes difficult for its purity to be maintained. The water is not so freely exposed to and mixed with the air, and its organic impurity is not so readily burnt off. If manufactories crowd its banks, and sewage from towns is cast into it in quantity, purification by natural means becomes almost impossible. River water, therefore, unless when taken high up the stream, is almost invariably contaminated, and forms an exceedingly unsafe source of supply.

Lake Water varies in composition according to the district over which the rain water and streams formed by it flow. When the lake is in an upland, surrounded by hills, from whose streams it is supplied, and when the hills are of hard formation, with little limestone, and when the lake has full and easy outlet by streams, the water is of a very pure and wholesome character. For the mountain streams in their descent dissolve little material, and the free outlet prevents the accumulation of solid material in the water. A lake like the Dead Sea, with little outlet but by evaporation, becomes highly charged with saline ingredients, for the evaporation continually causes concentration. Mountain lakes with free outlet form the most valuable sources of water supply, provided they are free of impurity from human habitations. A good illustration is Loch Katrine in Scotland, supplying Glasgow, which contains only 2 grains of solids per gallon; Thirlmere in Cumberland and Bala in Wales contain about the same amount. The total solids yielded by five gallons of Loch Katrine water might be heaped on a threepenny piece. Waters derived from peaty districts are often discoloured and flavoured by suspended matter derived from the peat, which is not, however, hurtful, and is easily separated by filtration. Such waters are often less pleasant, because of the smaller quantity of dissolved gases they contain; but these can be imparted to them by filtration through gravel and charcoal beds, which also improves them by permitting the process of combustion to occur, and thus removing traces of organic matter. In course of transit through iron pipes such waters undergo an improvement.

These various kinds of waters have been classified, as regards quality, by the Rivers Pollution Commissioners as follows:—

Wholesome	1. Spring water.	Very palatable.
	2. Deep well water.	
	3. Upland surface water.	Moderately palatable.
Suspicious....	4. Stored rain water.	
	5. Surface water from cultivated lands.	Palatable.
Dangerous...	6. River water to which sewage gains access.	
	7. Shallow well water, to which sewage gains access..................	

Sea Water is rich in salts, specially chloride of sodium, common salt. Of this salt the water of the British Channel contains over 2000 grains per gallon; magnesium salts are also present in considerable quantity, and salts of lime. Sea water contains also bromine and minute quantities of iodine and fluorine. The richness in salts is supposed to be due to the continued inflow from rivers, &c., of waters containing them in solution, which is never returned from the sea, as it loses only water by evaporation. Organic matters from vegetable and animal life present within it and derived from tributaries also, of course, abound, and gases are also present in solution. The composition of sea water varies in different places, according to the character of contributions made to it by rivers, and for other causes.

The Detection of Impurities in Water.—The determination of the nature and quantity of the various constituents of water is the business of the expert chemist, and the examination of one sample just sufficiently to enable him to say whether it is wholesome or not will occupy many hours, while its exact analysis will occupy days. In taking water for the purpose of sending it for analysis, persons should be careful to take a fair sample. The bottle used should be thoroughly cleansed, and after it is quite clean it should be rinsed out several times with the water that is to be collected. Care should be taken that the stopper is also quite clean. In the case of service pipes, the water should be taken if possible direct from the main. River water should be taken well in the stream, the bottle being plunged overhead. The best bottles are what druggists call Winchester quarts, of which two had better be sent, filled up to the neck, though one such quart would be sufficient for a partial analysis. The source of the water—well, river, lake, &c.—should be stated, as well as any circumstance as to situation of well, depth, surroundings, that may seem to have a bearing on its purity.

While a careful analysis is a very laborious proceeding, involving much knowledge and practical skill, it is yet possible for anyone to make a few rough tests with water that will suffice, for the time being, to indicate whether the water is subject to any marked impurity. For example, any householder might roughly satisfy himself as to the character of the water taken from a well attached to a country house where he wishes his family to holiday; and so on. The chief points to be noted are stated in the following paragraphs:—

Colour of the Water.—The water is taken in a long glass cylinder, standing on a white porcelain plate, and the plate looked at through the column of water. The colour of pure water is a greenish-blue, but it requires a mass of it, perhaps a depth of something like 10 feet, to show it clearly. But the column of water in a tube two feet long even will reveal any suspended matters giving other colour to the water. Mere traces of peaty matter and other material in suspension will be revealed in the brown appearance the porcelain plate will have when viewed through the column.

Odour of the Water.—Pure water has no perceptible odour. If any smell is detected the water is to be regarded with suspicion. A simple method of testing consists in filling an ordinary water-bottle to within a third of the top, with the water, closely covering the top with the palm of the clean hand, vigorously shaking the water, and then sniffing up with the nose thrust well into the mouth of the bottle, the hand not being removed till one is ready to insert the nose at once. If a bad smell is perceived, the water is impure. If no bad smell is perceived, the water is not necessarily pure. A more searching test consists in warming the water in a stoppered flask up to 100° Fahr., shaking it, and then suddenly removing the stopper and smelling it. Decaying animal and vegetable matter will be indicated by a bad odour. The same test may be applied, though not so quickly, by corking up some of the water in a clean bottle and setting it aside in a warm place for a day or two, then shaking the water and smelling it.

Flavour of the Water.—Not much can be learned from this. The purest water is the most insipid, from the absence of gases, and the best flavoured water may contain considerable organic impurity. Excess of salts will be readily detected; thus in the case of wells near the sea, the entrance of sea water gives a brackish taste.

To detect organic impurity in the water, there are two tests that may be employed with perfect ease. One is Nessler's test, the other is the test with permanganate of potash. The former detects ammonia in the water, and ammonia, as we have seen, is one of the products of the burning in the water of organic substances, so that the detection of ammonia by Nessler's test indicates that organic matter has previously gained access to the water, though it has had time to undergo change. The latter test is used to indicate whether there yet exist in the water organic substances not yet oxidized, still in a state of change, for this

would be a much more serious impurity than the former. In analysts' reports these two kinds of impurity are signified by the terms "free ammonia" and "albuminoid ammonia." The analyst determines first the quantity of ammonia existing as such in the water. He then wishes to know how much organic matter as such is present. To determine this directly is not an easy matter, and so he falls upon the expedient of chemically acting upon any organic matter the water may contain, so as to produce ammonia from it, and then he finds it easy to determine the quantity of ammonia so produced, and hence to calculate the quantity of organic substance that must have been present to yield it. Hence the use of the phrase "albuminoid ammonia."

Nessler's Test is ordered to be prepared as follows:—35 parts of iodide of potassium are dissolved in a small quantity of *distilled water;* a saturated solution of bichloride of mercury is now added, little by little; a red precipitate appears, which is almost immediately dissolved. In continuing to add, a point is at last reached when the precipitate commences to be insoluble. Sufficient bichloride solution has then been added, and the liquid is filtered. To the filtrate 120 parts of caustic soda (or 160 parts caustic potash), dissolved in water to a strong solution, are added. The total quantity of liquid is then made up to 1000 parts. Finally 5 parts of a saturated solution bichloride of mercury are added, to clear up the solution and make it sensitive. On standing a deposit appears, from which the clear liquid should be decanted into a large stock bottle, well corked. For use a small bottle should be used, filled from the larger as required to prevent frequent opening of the stock bottle, which would render it cloudy.

Now place some of the water to be tested in a clean glass, and add a very small quantity, a drop or two of the Nessler solution. Allow it to stand, covered, in a good light. The appearance of a yellow colour indicates the presence of a small quantity of ammonia. If a dark yellow be produced, still more a brownish colour, and still more if a yellow precipitate forms, the presence of ammonia in quantity is indicated. Nessler's test is said to indicate by the colour the presence of ammonia, should even so small a quantity as only 1 part of ammonia be present in 20,000,000 parts of water. And as the ammonia can readily be concentrated by distillation, the presence of only 1 part in 200,000,000 parts of water is said to be detectible by Nessler's test.

The Permanganate Test is applied by taking the water to be tested in a glass vessel, and adding about a tea-spoonful of weak sulphuric acid, then dropping in a few drops of a weak solution of permanganate of potash, and stirring with a glass rod. The permanganate is to be added till a rich rose-colour is acquired by the water. The vessel is then covered with a clean glass plate and allowed to stand in a good light. If there is any quantity of organic matter present the colour will go in a few minutes. A few more drops of the permanganate may be added, and the time that elapses before the colour is again destroyed noted. For the purpose of comparison a similar vessel containing distilled water may be set alongside the water to be tested, and coloured with the solution, and this may be used as a standard, as it should retain its colour, by which to judge of any change in the colour of the water being tested. The permanganate solution is robbed of its colour because it readily yields up the oxygen it contains to any body capable of becoming oxidized by it. Thus the organic matter seizes upon the oxygen, undergoes combustion, and becomes destroyed in the process. The quantity of the solution of permanganate requiring to be added time after time before the rose-colour is permanently obtained may, therefore, be made a measure of the quantity of organic material present in the water: the more organic matter, the more oxygen needed for combustion, and, therefore, the more permanganate decolorized. The results of the permanganate test require, however, to be taken with some reservation. Nitrous acid, commonly present in water, will also destroy the colour. Now nitrous acid indicates previous contamination of the water, that is organic impurity which, however, has undergone already partial destruction, and is not so serious a constituent as actual organic matter. Iron also destroys the colour. Good drinking water, such as Loch Katrine, will, however, have no perceptible effect on the colour till after the lapse of 24 or more hours, showing merely traces of organic material. Thus an ordinary analysis of Loch Katrine water shows of free ammonia 0·004 parts in 1,000,000, and of albuminoid ammonia 0·08 parts per 1,000,000.

If two tests mentioned, when applied to a particular sample of water, indicate organic impurity, a rough confirmatory test may be sought by applying the test for chlorides; for if sewage is gaining access to water, the quantity of chlorides is certain to be increased be-

cause of the quantity of chloride of sodium, common salt, in urine. The test is a drop of nitric acid and then a few drops of a weak solution of nitrate of silver (2 grains to the ounce are sufficient). This with good water will give a faint cloudiness, for a small quantity of chlorides is always present; but if there is a marked white precipitate produced, the evidence of sewage pollution is almost conclusive, always under the condition that the water has not been taken from near the sea-shore, where salt water could gain access to it.

The Detection of Lead in Water.—To the suspected water add a few drops of nitric acid, mix with a glass rod, then add a drop or two of sulphuretted hydrogen water. A very faint trace of lead will be revealed by a brown discoloration of the water. The delicacy of this test is exceedingly great. It will indicate the presence of 1 part of lead in 100,000,000 of water.

The Microscopic Examination of Water often reveals the presence of vegetable and animal matter, dead and living. By this means one will often be able to detect undoubted evidence of sewage contamination, owing to the presence of undigested remains of food, derived from excreta, fragments of vegetable tissue, starch grains, fragments of muscular fibre, and so on. Besides these, living forms are found in river water, water from ponds and marshes, surface water in general, and sometimes in the water of shallow wells. They are readily found in water contaminated by sewage, and they never occur in water of deep wells and springs, that are not polluted. Their presence is sure evidence of a dangerous pollution. These living forms belong to a great variety of species, desmids, diatoms, confervæ, infusoria of many kinds, animal forms of the worm family, and bacteria or germ forms. A drop of water from any stagnant pool abounding in decaying vegetable matter will show such things in multitudes. The presence of such living things in water—of all of them, or of any one kind of them—does not imply any special unwholesome character. It indicates that the water is impure, is being contaminated in various ways, and that opens up a vista of endless possibilities. The figure (Fig. 259) is one modified from Hill Hassall, who was the first to direct attention to the importance of the microscope in the examination of water.

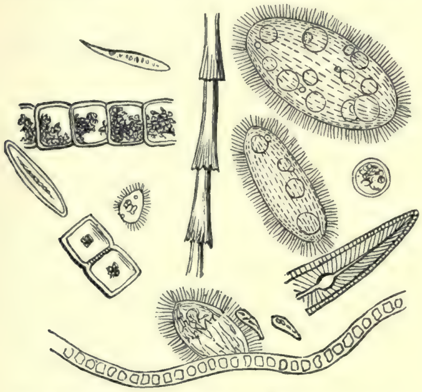


Fig. 259.—Some Animal and Vegetable Structures found in a Drop of Thames Water.

The Purification of Water.—**Filtration.**—The chief means of purifying water is by filtration. Now filtration acts in two ways. It acts obviously as a mechanical obstacle to the passage of matter contained in the water not in solution but in suspension. Consequently, water impure simply from the presence of earthy particles, peaty substances, and so on, which give a brownish tint to the water, is rendered quite clear by passing through the filter. But filters, specially the filters of gravel, sand, charcoal, and spongy iron, and the like, used for water filtration, act also chemically. As the water slowly finds its way through the pores of the filter, which are occupied by air, it meets with oxygen and the process of combustion goes on, so that the water that has passed through is purified, not merely because suspended matters have been removed, but also because some organic impurity has been consumed. Further, the water becomes aerated in its course through the filter, by taking up not only air, but carbonic acid produced in the oxidation process. Water companies filter the water they supply in large paved tanks provided with perforated tubular drains, which are covered by several feet of gravel, coarse at the bottom and becoming fine at the top, while over the gravel is a layer of sand several feet deep. The water is slowly and regularly admitted to the tank, the depth of water being never very great, in order that the water may not be forced through. For filtering purposes, however, nothing is equal to pure well-packed animal charcoal, which removes organic impurity much more thoroughly than other materials. The silicated carbon filter, magnetic carbide of iron filters, and filters of spongy iron are also very reliable. Slow filtration through a layer of animal charcoal, in coarse powder, 4 inches thick, will, according to Wanklyn, purify river water containing a considerable quantity of organic impurity. After being used some time the charcoal needs

renewal or cleaning. It may be cleaned by washing it first with a solution of permanganate of potash (10 to 15 grains to the pint of distilled water, with a few drops strong sulphuric acid), then in dilute hydrochloric acid (60 drops to the gallon of water), and then in pure water, afterwards drying it. Merely exposing the charcoal to the open air for some hours will destroy the organic impurity it has retained, or exposing it to a considerable heat.

Filters for Domestic Use.—Two kinds of filters are shown in Figs. 260 and 261. The latter consists of a block of carbon through which the water requires to pass to get from the upper to the lower vessel. The former is a

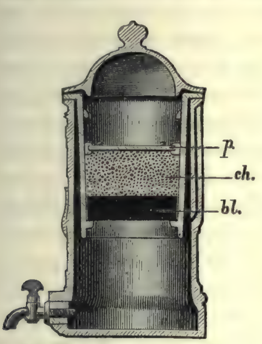


Fig. 260.—Cleansible Filter.

Fig. 261.—Glass Table-filter.

specimen of one kind of filter, of which there are now many in the market, which are easily cleaned. The large earthenware jar contains within it a smaller one containing the filtering apparatus. The latter is formed of a block of carbon (bl), and above it a layer of granulated charcoal (ch), kept in position by a porous earthenware plate (p). All these parts can be removed for renewal or cleansing. The water is poured into the upper part of the inner jar and passes through the filtering beds to the space below.

Domestic filters require attention to secure constant cleanliness. It is to be feared that many filters are used year after year, without ever being cleaned. Under such circumstances they are more likely to render the water that passes through them impure than to purify them. Even when the organic impurity in the filtering water is small, the filter should be cleaned or renewed every few months, and oftener if the water contains much contamination. Many filters require returning to the makers for cleaning, others may be renewed and cleaned by any one with ease. Parkes gives the following directions for the cleaning of filters to avoid taking them to pieces:—Every two or three months (according to the kind of water) air should be blown through, and if the charcoal be in the block form it should be brushed. Then 4 to 6 ounces of the pharmacopœial solution of potassium permanganate, or 20 to 30 grains of the solid permanganate in a quart of distilled water, and 10 drops of strong sulphuric acid should be poured through, and, subsequently, a quarter to half an ounce of pure hydrochloric acid in 2 or 4 gallons of distilled water. Three gallons of distilled or good rain water should then be poured through, and the filter is fit again for use. If the filter can be taken to pieces the charcoal can be spread out in a thin layer, and exposed for some time to the air and sun, or strongly heated in an oven.

A simple filter for domestic use may easily be made with a flower-pot. The lower part is filled with coarse pebbles, over which is placed a layer of fine pebbles, and above that a layer of clean coarse sand. On the top of this, place a piece of burnt clay perforated with small holes, and cover it with a layer, 3 or 4 inches thick, of well-burnt pounded animal charcoal.

Clarification of Water by Alum, Oak Chips, &c.—When it is suspected that a considerable quantity of organic impurity is present it is well to boil the water before it is filtered. It may afterwards be mixed with air by agitation. Another method of purifying water consists in adding to it something which will clarify it, as white of egg is added to jelly for the same purpose. Alum has specially been used for this purpose, of which 6 grains is added to each gallon of water. The action is most effective when the water contains carbonate of lime, the sulphuric acid of the alum leaves it to combine with the lime to form sulphate of lime, and the alumina, which is insoluble, is precipitated, carrying with it suspended matter.

If the water contains little lime carbonate, if, that is to say, it is very soft water, it is advised that a little chloride of lime and carbonate of soda be dissolved in it before the alum is added. The sediment is then allowed to settle and the clear water drawn off. In a similar way will the addition of some astringent substances cause a purifying of water, such as chips of oak. Thus the muddy water of the Nile is clarified by rubbing the inside of the water vessel with bitter almonds, and in India the Hindoos rub the inside of the water-jar with the fruit of the *Strychnos potatorum.* The fruit is beaten into a paste, of which about 30 grains are used for 100 gallons of water, and it is allowed to act for 24 hours. Or one of the

seeds is simply "rubbed for a minute or two round the inside of the vessel containing the water, generally an unglazed earthen one," and in a very short time the impurities fall to the bottom leaving the water clear and apparently wholesome. It is chiefly used for river water at the season when it is laden with suspended matters. Probably the effect produced upon the bitter waters of Marah by casting in the tree was similar to that of alum, oak chips, or the fruit of *Strychnos potatorum*.

Purification by Condy's Fluid.—When water contains a large quantity of organic matter, more than a filter can readily dispose of, and when no other water is easily procurable, it may be made tolerably safe and wholesome by means of permanganate of potash. Parkes advises as follows:—"In the case of any foul-smelling or suspected water, add good Condy's red fluid (that is, a solution of permanganate of potash), tea-spoonful by tea-spoonful, to 3 or 4 gallons of the water, stirring constantly. When the least permanent pink tint is perceptible, stop for five minutes; if the tint is gone, add 36 drops, and then, if necessary, 30 more, and then allow to stand for six hours; then add for each gallon 6 grains of a solution of crystallized alum, and if the water is very soft, a little calcium chloride and sodium carbonate, and allow to stand for twelve or eighteen hours. If not clear or if discoloured, filter through charcoal." In any case it will be well to filter through charcoal, as some of the organic matters may not be oxidized by the permanganate, and the filtration through charcoal may remove them.

Finally, it has been already mentioned how by boiling, or by the addition to water of a little unslaked lime, hardness of water may be greatly diminished, and how, by the addition of common soda, all hardness may be removed. The latter, however, must not be added to water to be used for drinking or such purposes.

Impure Water as a Cause of Disease.—Impure water may be a source of disease in a double way. It may produce simply a bad state of general health through its effect upon the digestive system, stomach, bowels, &c. Thus, there seems no doubt that vague ill-defined digestive troubles, dyspepsia, diarrhœa, sickness, dysenteric conditions, and so on, may arise from the use of impure waters. Such conditions may very often have such a cause when it is least suspected. It appears, moreover, that waters containing simply excess of inorganic salts, very hard waters, may occasion disturbance referred to the bowels, constipation, and so on. But, in the second place, water may be the medium of conveying specific disease. There is now no manner of doubt that water affords a medium for the propagation of typhoid fever and cholera, owing not to simple organic impurity, but to the specific poison of the disease gaining access to the water in sewage, containing the excreta of patients suffering from such diseases (see p. 187). Goitre has been shown to be associated with a particular kind of water (see p. 210), and various malarial diseases have their home in marshy places, where there is insufficient vegetation to employ the resources of the soil (see p. 427). Moreover, various forms of intestinal worms may be propagated by the ova of the worms gaining entrance to the water. This is illustrated in detail on p. 170. Now there is really no means of determining, as already stated, when an organic impurity in water is simply unpleasant and undesirable, and when it contains a specific poison capable of occasioning an epidemic. This is exceedingly well put in the following paragraphs from Wynter Blyth:—"Nothing is more clearly proved than the fact that a large population may drink a sewage-polluted water with the utmost impunity, under certain conditions. A few years ago the author proved that a town in Somersetshire had drunk a water-supply from shallow wells which was nothing more nor less than dilute sewage; and yet the death-rates from fever, from dysentery, and all other diseases supposed (and rightly supposed) to be propagated by water, were remarkably low in comparison with places drinking a pure water. Here, then, was an experiment ready made on more than a thousand persons, and the negative results recorded for the best part of a century. It proved that under ordinary conditions the water was harmless, and yet what chemist could pass such? The colour, taste, and smell, as well as the organic carbon, nitrogen, and microscopical characters, all combined to show that the characters of the supply were of great impurity; on the other hand, water of very moderate impurity, as shown by ordinary chemical and microscopical investigation, has many times been as fatal as a solution of some subtle poison. These, as it were, unconscious experiments continuously proceeding in towns, in villages, and in solitary homes, demand the closest study; and such a study will, in years to come, make clear the apparent discrepancy often existing between chemical and biological analyses. Possibly the conclusion already

shadowed forth is this:—Water, however polluted by healthy human or animal sewage, nasty and abominable liquid as it may be, will produce no disease; water infected with the excretions from diseased natures will cause disease.

"Since, however, at the present time we cannot differentiate between those excrementitious matters which cause disease, and those which do not cause disease, *it is clearly safest to condemn as a supply a liquid which has been proved to be contaminated by a something, which, for ought we know, contains the seed of typhoid fever or of cholera.*"

Aerated Waters are waters which contain gas dissolved in them, so that the term might be applied to ordinary water, since it contains oxygen, nitrogen, and carbonic acid gas in solution. The term, however, is restricted to those waters which contain gas dissolved in them in such quantity, that when they are exposed to the ordinary atmosphere the gas comes off in bubbles, giving a sparkling quality to the water. Water is capable of dissolving any kind of gas to greater or less extent, but the most readily soluble of the ordinary gases is carbonic acid gas, and it is with this gas that the majority of aerated waters are charged. There are some natural waters, such as those of Seltz, Vichy, and Spa, which contain carbonic acid gas in such quantity that they effervesce in the open air, and such waters are called **natural aerated waters.** The carbonic acid gas is derived in their case from the ground, in which it exists in some districts in large quantities, specially in volcanic and limestone districts, being collected often in large volumes, because of difficulty of escape, and being, therefore, under great pressure. It is found at the bottom of deep wells and mines, in caverns, &c. Collections of it in mines are called "choke-damp," because of its suffocating character. The term "aerated waters," as commonly employed, however, means water which has been designedly charged with gas, usually carbonic acid, for the production of a pleasant sparkling beverage; and it is these **artificial aerated waters** that we shall consider here.

First of all it is needful to state a few of the characters of the gas.

Carbonic Acid Gas is produced wherever carbon or carbon-containing substances are burnt, being formed by the union of carbon with oxygen, in the proportion of one combining weight of carbon to two combining weights of oxygen, and it is, therefore, represented by the chemical formula CO_2. The gas consists, in round numbers, of 28 per cent carbon, and 72 per cent oxygen. The gas is also produced as a result of chemical changes going on in living structures, both vegetable and animal, the product of combustion occurring within them, ending in the liberation of heat and energy (see p. 527), and is given off in the gases of respiration as a waste product. Carbonic acid gas is likewise produced in all processes of fermentation

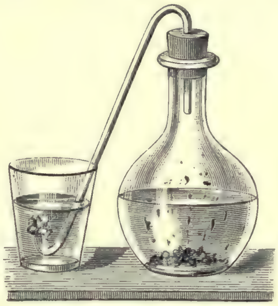


Fig. 262.—Arrangement for producing Carbonic Acid Gas.

and putrefaction. The ordinary processes of decay of animal and vegetable substances have as their ultimate object the oxidation or combustion of the complex organic body, and its consequent reduction to simple substances. This we have seen goes on in water, by the agency of the dissolved oxygen, and goes on by simple exposure to the air, even as it goes on, though with much greater rapidity, in a coal fire. In the course of fermentation it is one of the products, and it is because of its production that fermented beverages have their brisk, sparkling character, the gas being prevented from escaping. Carbonic acid gas may be readily produced in quantity, by acting on chalk or marble with dilute hydrochloric acid, or by heating chalk or marble to redness in an iron or earthen retort. Fig. 262 shows a very simple arrangement, which any one could make for himself, for the production of the gas. Into the flask is placed some marble, broken small, and then some muriatic or hydrochloric acid—spirit of salt, it is also called—diluted with water (1 part of the acid to 10 of water would suit). The gas at once proceeds to come off. The flask is now corked with a tightly-fitting india-rubber cork, through which passes a glass tube. The tube is bent downwards, and may dip into a vessel of water, through which the gas will then be seen to bubble. If, instead of ordinary water, the vessel contains lime water, as soon as the gas begins to bubble

through it, it will become milky, through the formation of carbonate of lime, which will not dissolve in water, and so is precipitated as a white powder. To make certain that the gas is obtained pure, instead of the vessel of water, substitute a second flask like the first, half fill it with pure water, and let the tube from the flask generating the gas pass through the cork, nearly to the bottom. Let a second tube pierce the cork, not being prolonged far into the flask. The gas will pass into the water from the first tube, bubble through it, being washed in course, and will collect, purified, in the upper part of the flask, from which it will escape by the second tube, and by a prolongation of the tube may be led wherever one wishes.

Carbonic acid gas is a heavy gas, more than $1\frac{1}{2}$ times heavier than air, and it will consequently displace air, just as water will, and may be poured like water from one vessel to another. It is, however, colourless, and therefore invisible, and one, therefore, cannot tell when a jar has been filled with it. A very simple test will, however, settle that question. Suppose one wished to collect a jarful of the gas: all that is needful is to take the jar, or say a large wide-mouthed bottle, with a glass stopper, such as druggists employ, and having made certain of its cleanness, pass the tube coming from the apparatus, described above for washing the gas, down to the bottom of the bottle. The gas flows in, as water would, displacing the air. As soon as the bottle is full, it will flow over as water would. If a lighted taper be held close to the mouth of the bottle, as soon as the gas begins to flow over, the taper will be extinguished. The jar is then full, and if the stopper fits well and is securely fixed, its edges being slightly greased with lard to ensure perfect closure, the gas may be kept any time.

The extinction of the taper is due to the fact that the gas is incombustible. It is the product of combustion, and will not support combustion. Combustion cannot go on without oxygen, and as soon as the taper is surrounded by an atmosphere of the gas it receives no oxygen and therefore goes out. It is consequently a gas which, if breathed in any quantity, or if present to any great extent in the atmosphere inhaled, interferes with respiration, slowly, rapidly, or instantaneously, according to the extent to which it is present. It is, we have said, a heavy gas, and therefore collects at the bottom of wells, pits, &c. A man descending into such a well, without precaution, would be plunged into an atmosphere of the gas, and would at once fall unconscious, being extinguished like the candle flame. If the test already indicated were applied, and if the man, before deciding to descend, lowered a lighted candle, he could find by its extinction, or its continuing to burn, whether it was safe for him to descend. Not only does it interfere with respiratory processes going on in the body, when inhaled, but it also exerts a directly poisonous influence on the nervous system, so that an atmosphere containing plenty of oxygen for respiratory purposes would yet be poisonous, if it also contained a certain proportion of carbonic acid gas. (See next Section.)

Carbonic acid gas is very soluble in water, a certain bulk of water being able to dissolve an equal bulk of the gas. So that if a pint of pure water be introduced into a pint bottle filled with carbonic acid gas, the gas will all be dissolved in the water. The gas, like other gases, may be compressed, that is, when submitted to pressure, it can be made to occupy a smaller space. If a graduated cylinder, fitted with an air-tight piston, be filled with the gas, and then the piston pressed down with a pressure equal to that of the atmosphere, the gas will be compressed to one-half its bulk. If the piston were to be relieved of pressure it would be forced back to its original position by the expansion of the gas. Suppose the original pressure of the atmosphere is trebled, the volume of the gas would be reduced to a third. Now, even in this compressed state, water will dissolve its own bulk of carbonic acid gas, so long as the pressure is maintained. Thus, suppose a jar, fitted with a piston, and holding 4 pints of gas, and suppose at ordinary atmospheric pressure a pint of pure water to be introduced, the water would dissolve its own bulk of gas, namely, 1 pint. Suppose now a pressure equal to 15 lbs. to the square inch to be applied, that would reduce the 4 pints of gas to 2 pints, 1 pint of which (its own bulk) the water would dissolve, and thus the piston would come down half-way in the jar, the remaining half being occupied by the pint of water with 2 pints of gas dissolved in it, and the pint of compressed gas representing 2 original pints. Or suppose at first the pressure on the piston had been equal to four times the atmospheric pressure, that would have reduced the bulk of the gas to 1 pint, and this 1 pint would be dissolved by the pint of water, so that with this pressure the piston would sink to the level of the surface of the water, all the gas being dissolved. Under great pressure, then, water can be caused to dissolve a very large quantity of carbonic acid

gas. If the pressure be diminished, a proportion of the gas will be given off, and, if all the extra pressure be removed, all the gas will be evolved with effervescence, except what the water would dissolve under ordinary atmospheric pressure. Even this may be driven off if the water is heated. The reason of the effervescence of aerated water as soon as the cork is removed is evident from these explanations, as well as the bursting in summer weather of bottles containing such water.

The various aerated waters in common use consist of water charged under pressure with carbonic acid gas, to which also some particular flavouring agent has been added.

In aerated water manufactories the gas is prepared in large cylinders from chalk by the action of an acid. It is then purified by being passed through a series of vessels which rid it of foreign gases, the last of the vessels containing pure water. Thence the gas is passed to a gasometer of large size, where it is stored under a pressure of several atmospheres. From this gasometer the gas is carried by a tube to a cylinder in which pure water is contained. The gas is mixed with the water by agitation under pressure, and a sufficient quantity of gas forced into the water till a permanent pressure of twice the ordinary atmospheric pressure is reached. Simple aerated water, which is frequently called soda water, is this water charged with carbonic acid gas, without any other addition. It is run into bottles by means of a special tap and other arrangements, which prevent the escape of the gas. By means of the bottling machines now in use, the water can be bottled with extraordinary rapidity and little loss. During all the stages of the manufacture the mode of transference of gas from one cylinder to another is arranged to prevent any atmospheric air gaining admittance. Into the charged cylinder the appropriate quantity of bicarbonate of soda, potash, &c., can be introduced, if actual aerated soda water or potash water is required.

Soda Water.—As already explained, many people speak of soda water when they mean simply aerated water. Actual soda water contains 30 grains of bicarbonate of soda to every imperial pint of water, that is, each ordinary bottle, which holds $\frac{1}{2}$ pint, should contain 15 grains of bicarbonate of soda in solution. The British Pharmacopœia directs that the quantity of gas with which it is charged should sustain a pressure of seven atmospheres.

Potash Water should contain 30 grains carbonate of potash to each pint.

Lithia Water contains 10 grains carbonate of lithium per pint.

Lemonade is simply aerated water passed into a bottle, into which there has been previously put a small quantity of syrup, flavoured with lemon. There are many other drinks, exactly similar in character, varying only in the flavour which has been imparted to the syrup, such as gingerade, orangeade, and drinks flavoured with raspberry vinegar, and other fruit syrups. Gingerade is usually slightly coloured, and has added to it some mucilaginous material, which prevents the too speedy escape of the gas when it is drawn, and thus causes the more permanent "head" to appear, which the public thinks the appropriate quality of gingerade in particular.

Ginger Beer is really an alcoholic beverage, and is considered under alcoholic drinks.

Oxygenated Water, that is water which is charged with oxygen under pressure, has recently come into use, and it is said to have an exhilarating effect, and to be useful in cases of diabetes, as well as in some forms of indigestion, sluggish liver, and so on. Water, it is to be noted, dissolves oxygen much less freely than carbonic acid gas.

These aerated waters are pleasant beverages possessing little properties beyond that of ordinary water. The escape of the gas produces a sharpish, pleasant taste, and has a gentle stimulating action on the stomach, while the gas itself is somewhat soothing, and is often exceedingly grateful in cases of irritable stomach.

Contamination of Aerated Waters.—The quality of aerated waters depends naturally upon the quality of the water used in their manufacture. Aerated waters may, therefore, be very unwholesome, owing to organic or other impurity, if the manufacturer has not been scrupulously careful as to the source and condition of the water used. Supposing, then, that the water is pure, the risk is contamination with lead, for carbonic acid gas very readily attacks lead, and if in any part of the apparatus, used for the manufacture, a lead joint or a lead surface of any kind is exposed, the water will rapidly dissolve some of the metal. Lead poisoning from such sources are not by any means unknown. Tinned copper cylinders are usually employed in the manufacture to prevent this. But further contamination may arise from the syphons in which aerated waters are now so commonly sold, or gazogenes in which aerated waters in small quantities are made in households. The attachment of the

glass tube which passes down the inside of the syphon, being often made of pewter, leads to this risk.

The detection of lead in aerated water may be made in the way noted (on p. 648) for its detection in water.

Mineral Waters.—These being medicines rather than beverages, are discussed in the part devoted to drugs.

TEA, COFFEE, COCOA, CHOCOLATE, &c.

Tea, coffee, cocoa, and many other substances used for the preparation of drinks, have several common features, of which it may be well to take general notice before considering each of the substances in detail.

1. They all contain an active principle, or alkaloid, containing nitrogen, akin to the active principle atropin, of the deadly nightshade (belladonna), akin to strychnine, to quinine, and to nicotine, the active principle of tobacco. In the case of tea this active principle is **thein**, in the case of coffee it is called **caffein**, and in the case of cocoa, **theobromin**, but the two former are apparently identical.

2. They all possess an aromatic oil, on which the flavour or aroma of the infusion depends. This oil does not exist in the substances in their fresh state, but is produced in the drying and roasting processes followed in their preparation for the market.

3. Tea and coffee contain an astringent substance, tannin in the case of tea, and a modification of tannin in the case of coffee. It does not exist in cocoa, or at least is present only in very small quantity.

4. Besides these there exists a variety of substances which are of no moment from the point of view of those who are considering their value as beverages, however interesting they may be to the analytical chemist. These substances are albuminoids, gum, dextrin, fat, wax, colouring matters, woody fibre, and mineral matters.

The active principle, aromatic oil, and astringent substance are worth fuller consideration.

Thein, or **Caffein,** for the two are identical, was discovered in coffee-berries in 1820. It had been previously discovered by Leeuwenhoeck, whose remarkable microscopic work has been referred to on p. 385, but had been afterwards overlooked. It is found not only in the coffee-bean but also in the leaf of the coffee-plant. In tea it was discovered in 1827, but it was not till eleven years later that the active principle of coffee, which had been called caffein, and that of tea, which had been called thein, were found to be one and the same substance. In 1841 the active principle of cocoa was discovered. It very much resembles thein. It is owing to the presence of this active principle that all these substances possess their stimulating property. Other substances used in a similar way to tea, coffee leaves, for example, Maté or Paraguay tea, and the kola-nut, also possess the same active principle as tea. "It is remarkable," says Attfield, who discovered the presence of thein in the kola-nut, "that the instinct of man, even in his savage state, should have led him to select, as the bases of common beverages, just the four or five plants which out of many thousands are the only ones, so far as we know, containing thein."

Thein can be obtained in fine white needle-shaped crystals, and may be easily separated by anyone who cares to take a very little trouble. Put a few finely-powdered leaves into the bottom of a clean cold test-tube, add a little water, and boil over a spirit-lamp till the water is nearly all driven off. Add a pinch of dry magnesia, and mix with the leaves, with the aid of a glass rod, into a sort of paste. Then gently warm the bottom only of the tube in the flame of the spirit-lamp. The thein will be driven off and will be deposited on the upper cold part of the tube in fine needles, where the naked eye will be able to perceive them, and a magnifying-glass will make them very distinct. The same process may be carried out in a tea-spoon over a gas flame, a slip of cold glass being held over the spoon to condense the crystals.

Thein has no smell but a slightly bitter taste. Its effects upon the healthy human body have been tested directly. In small doses it accelerates the pulse and the breathing, and quickens ordinary muscular movements. It increases the action of the skin, and apparently also of the kidneys. It also excites the nervous system, quickening thought. In fact it produces in small doses those effects, the experience of which has led a cup of tea to be the unfailing resort as a cheering and gently-stimulating beverage. It diminishes the tendency to sleep and removes some forms of headache. In large doses it acts as a poison, producing nervous excitement, trembling of hands and arms, and restlessness, and ultimately narcotic effects. A dose of 4 grains is fatal to a cat, nervous symptoms being prominent. A full tea-spoonful of tea would yield from 1 to 3 grains of thein—probably on an average about 2½ grains.

Theobromin is chemically related to thein. Its

poisonous action is not so pronounced, though 15 grains proved poisonous to kittens.

The aromatic oil of tea is of a citrin-yellow colour, with a strong aroma of the tea. It is produced in the drying of the tea, by some unknown chemical change the processes induce. The oil is volatile. In the case of coffee it is produced during the act of roasting; and if the roasting be unskilfully done, the oil produced may be driven off. Persons who roast their own beans require a little practice to enable them to hit the point when the highest degree of flavour has been produced, and the least given off. Many people wonder why the coffee gave out such a delicious odour when being roasted, and why the infusion was so devoid of flavour —the reason being that they had dissipated the essential oil in the atmosphere. The essential oil of cocoa is also a product of the roasting. It is contained in smaller amount than in tea or coffee. The action of the aromatic oils has not been very thoroughly investigated, but Johnston thinks that, besides conferring the aroma on the tea, coffee, &c., it most likely exercises a narcotic influence, rendered probable by many known facts. "Among these I mention the headaches and giddiness to which tea-tasters are subject, the attacks of paralysis to which, after a few years, those who are employed in packing and unpacking chests of tea are found to be liable; and the circumstance that, in China, tea is rarely used till it is a year old, because of the peculiar intoxicating property which new tea possesses. The effect of this keeping upon tea must be chiefly to allow a portion of the volatile ingredients of the leaf to escape. And lastly, that there is a powerful virtue in this oil is rendered probable by the fact, that the similar oil of coffee has been found by experiment to possess narcotic properties." The essential oil of coffee gently stimulates the skin and bowels, and also the nervous system.

The astringent constituent of tea is tannin, a constituent also of oak bark and many other plants. It is this ingredient which produces the bitter astringent taste, so well marked specially in a long-standing infusion. It also confers upon tea somewhat of a constipating effect, more notable when tea is used strong and dark. It has been supposed to be the tannin also which makes tea rather apt to produce indigestion, but Dr. Roberts of Manchester is inclined to think that this property is due to other acid constituents, and not to the tannin. It is quite certain, however, that if strong black tea, long infused, be habitually taken, the tannin exercises an injurious influence on the mucous membrane of the stomach, owing to its astringent action. Caffeic or caffeo-tannic acid is the modification in which the astringent principle is present in coffee, though it is contained in considerably less quantity than the tannin of tea. In some cocoas tannin is present in exceedingly small amount, and in others apparently not at all.

We shall now consider tea, coffee, &c., separately, their general features, possessed in common, having been noted.

Tea is the product of a plant, *Thea sinensis*, belonging to a section of the genus *Camellia*, of the natural order *Columniferæ*, of which there are three main varieties, *Thea viridis* (Fig. 263) and *Thea bohea* (Fig. 264), native to Bengal and parts of China, and *Thea assamica*, native to Assam. The two former supply the China teas, and the latter Indian teas. The plant, it is believed, was really introduced to China from India, as early as the sixth century of the Christian era. In the eighth century it was introduced to Japan, and in the beginning of the seventeenth to Europe, and about the middle of the seventeenth century it reached Britain. The plant is a hardy evergreen flowering shrub, five or six feet high, though by cropping the upward growth is kept down to about three feet, and the lateral growth thus encouraged. If left alone it would grow to the dimensions of a tree. The plant is grown from seed, sown in March, the seed being kept during the previous winter in moist earth. The year-old shrubs are planted out in rows, a space of three or four feet intervening between each row. The leaves are not removed till the fourth or fifth year. Thereafter three or four crops are taken each year, the first in early spring, the second at the beginning of May, the third about the middle of June, and the fourth in

Fig. 263.—Thea viridis.

Fig. 264.—Thea bohea.

August. The first leaves, however, are the finest, and have the most delicate flavour. The leaves of the later gatherings are larger, more woody and bitter. The qualities of tea vary much, according to the period of the gathering, and according to the climate, soil, and other circumstances, the preparation of the leaves for the market very materially affecting the quality. The leaves are plucked by hand, women and girls being employed in the work. Four pounds of the green leaves yield one pound of dried tea. The mode of treating the fresh leaves depends on whether green tea or black is to be produced, the difference being one simply of preparation. To obtain green tea, the fresh leaves are spread out in thin layers on flat bamboo trays for from one to two hours, to allow them to dry slightly. They are then thrown into roasting-pans, heated over a wood fire, where they are moved rapidly about and become moist and flaccid and give off considerable vapour. In a few minutes they are transferred to a table, where they are rolled by hand. A second time they are put into the pan, over a slow charcoal fire, in which they are kept in rapid motion by hand, and in from an hour to an hour and a half, perhaps after a second rolling, they are finished. They are of a green colour, which subsequently brightens, the change of colour to black being prevented by the rapid roasting. Thereafter the tea is winnowed and separated into the various qualities and refired. When it is desirable to produce black tea, the leaves are allowed to lie in heaps for twelve hours or so, during which a species of fermentation occurs, which changes the natural hue of the leaf to a dark colour. Thereafter the various processes of drying, rolling, and roasting are carried out. The processes are thus described:—The leaves, after being brought in from the plantation, "are spread out upon large bamboo mats or trays, and are allowed to lie in this state for a considerable time. If they are brought in at night they lie till next morning. The leaves are next gathered up by the workmen with both hands, thrown into the air, and allowed to separate and fall down again. They are tossed about in this manner, and slightly beat or patted with the hands for a considerable space of time. At length, when they become soft and flaccid, they are thrown in heaps, and allowed to lie in this state for about an hour, or perhaps a little longer. When examined at the end of this time, they appear to have undergone a slight change in colour, are soft and moist, and emit a fragrant smell. The rolling process now commences. Several men take their stations at the rolling table and divide the leaves among them. Each takes as many as he can press with his hands, and makes them up in the form of a ball. This is rolled upon the rattan-worked table, and gently compressed, the object being to get rid of a portion of the sap and moisture, and at the same time to twist the leaves. These balls of leaves are frequently shaken out, and passed from hand to hand until they reach the head workman, who examines them carefully to see if they have taken the requisite twist. When he is satisfied of this, the leaves are removed from the rolling table, and shaken out upon flat trays, until the remaining portions have undergone the same process. In no case are they allowed to lie long in this state, and sometimes they are taken at once to the roasting-pan. The next part of the process is exactly the same as in the manipulation of green tea. The leaves are thrown into an iron pan, where they are roasted for about five minutes, and then rolled upon the rattan table. After being rolled the leaves are shaken out, thinly, on sieves, and exposed to the air out of doors. A framework for this purpose, made of bamboo, is generally seen in front of all the cottages among the tea hills. The leaves are allowed to remain in this condition for about three hours: during this time the workmen are employed in going over the sieves in rotation, turning the leaves and separating them from each other. A fine dry day, when the sun is not too bright, seems to be preferred for this part of the operation. The leaves having now lost a large portion of their moisture, and having become considerably reduced in size, are removed into the factory. They are put a second time into the roasting-pan for three or four minutes, and taken out and rolled as before. The charcoal fires are now got ready, a tubular basket, narrow at the middle and wide at both ends, is placed over the fire. A sieve is dropped into this tube, and covered with leaves, which are shaken on it to about an inch in thickness. After five or six minutes, during which time they are carefully watched, they are removed from the fire and rolled a third time. As the balls of leaves come from the hands of the rollers, they are placed in a heap until the whole have been rolled. They are again shaken on the sieves as before, and set over the fire for a little while longer. Sometimes the last operation—namely, heating and rolling—is repeated a fourth time; the leaves have now assumed a dark colour. When the whole have been gone over

in this manner, they are placed thickly in the baskets, which are again set over the charcoal fire. The workman now makes a hole with his hand through the centre of the leaves, to allow vent to any smoke or vapour which may rise from the charcoal, as well as to let up the heat, which has been greatly reduced by covering up the fires. The tea now remains over the slow charcoal fire, covered with a flat basket, until it is perfectly dry, carefully watched, however, by the workman, who every now and then stirs it up with his hands, so that the whole may be equally heated. The black colour is now fairly brought out, but afterwards improves in appearance. The after processes, such as sifting, picking, and refining, are carried on at the convenience of the workmen" (Fortune).

The quality of tea, as has been said, depends not only upon soil, cultivation, and preparation, but also upon the picking. The first crop, consisting of the young leaves, just bursting or barely expanded, and buds, is the finest. It is called Pekoe, which means white down, or Flowery Pekoe, because of the fine hairs or down clothing the leaf. Congou, Souchong, and Caper are other qualities of black tea. "Caper is in hard grains, made up of the dust of the other varieties cemented together by means of gum." Bohea is the commonest description, scarcely now found in the market. Twankay, Hyson Skin, Young Hyson, Hyson, and Gunpowder are various qualities of green tea, the Gunpowder being the finest quality, prepared from similar pickings to Pekoe. Some of the highest qualities of teas do not reach the market as such, being kept for blending. Various sweet-smelling plants are used for scenting teas, the sweet-scented olive for example, and thus there are scented Caper, orange-scented Pekoe, and so on.

The composition of tea is stated by Koenig as follows:—

Water	11·49	per cent.
Thein	1·35	,,
Essential oil	·67	,,
Tannin	12·36	,,
Nitrogenous substances	21·22	,,
Fat, colouring matter: wax, gum, dextrin	10·75	,,
Other non-nitrogenous substances	16·75	,,
Woody fibre	20·30	,,
Ash	5·11	,,

In other analyses the thein is stated as 2·0 per cent, 2·5 per cent, 3 per cent, and even more, the quantity varying with the quality of the plant, and in the same way the quantity of the essential oil varies, while the tannin, according to some, is as high as 15 per cent. It is worthy of notice that the quantities of the chief substances vary with the age of the tea leaf, the young leaves containing more water, but also more thein than the old leaves, while the latter contained more tannin and salts. It is well to contrast these quantities with those of the same constituents in coffee and cocoa, in the former of which the thein scarcely reaches 1·5 per cent, in some kinds falling as low as ·6 per cent, while the aromatic oil is only about a $\frac{3}{1000}$th per cent, and the tannin may reach only 4 per cent, while in the latter the theobromin is 1·5 per cent, and the aromatic oil is too small in quantity to be stated.

The nitrogenous substances, it might be supposed, would be of value as food; but it must be remembered that only an infusion of the leaf is commonly used, and that in boiling water the large proportion of albuminoids is insoluble, so that they are not consumed in any quantity. It has been found, for example, that half a pint of tea, made from a large tea-spoonful of the dry tea, will dissolve only about 38 grains of the material of the leaf, of which the tannin is stated at about 7½ grains, and the thein 2½ grains, while the mineral substances would be about 6 grains, leaving only 22 grains as the total of gummy, sugary, and nitrogenous substances extracted. The value of these 22 grains is, of course, not worth considering. The mineral substances consist principally of potash salts, magnesia and lime salts, phosphoric acid being also present in considerable amount.

The Value of Tea as a Food-stuff. As an example of the composition of a cup of tea, and an illustration of its valueless character as a food-stuff, that is as supplying anything for the repair of wasted tissue and yielding of energy for work or heat, I quote the following table from Attfield:—

Constituents of One Cup (seven ounces of Tea) containing average amounts of Cream (½ oz.) and Sugar (100 grains).

	Grains.
Cheesy matter from the cream	5
Fat and milk sugar ,, ,,	30
Added sugar	100
Mineral matter of the cream	1
Extract of tea leaf (mineral matter 4¾; organic 16¼)	21
Total	157

The small quantity really derived from the tea is striking; and if one takes no sugar the total amount of dissolved solids is only 57 grains, while probably half the quantity of cream

stated here is all that is usually taken. Tea, therefore, cannot be considered as yielding anything in the nature of nutriment to the body. It is simply a pleasant beverage, being used entirely for the effects due to its essential oil and active principle. The action of thein and the essential oil, given separately, has been already considered. It has been said that while tea supplies no nutriment to the body, it yet diminishes tissue waste, and thus saves the consumption of food to a slight extent, chiefly by the action of the thein. Johnston puts it thus: "The introduction into the stomach of even a minute proportion of thein—three or four grains a-day—has the remarkable effect of sensibly diminishing the absolute quantity of waste products of the tissues voided in a day by a healthy man, living on the same kind of food, and engaged in the same occupation, under the same circumstances. This fact indicates that the waste of the body is lessened by the introduction of thein into the stomach—that is, by the use of tea. And if the waste be lessened, the necessity of food to repair it will be lessened in an equal proportion. In other words by the consumption of a certain quantity of tea, the health and strength of the body will be maintained in an equal degree upon a smaller supply of ordinary food. Tea, therefore, saves food—stands to a certain extent in the place of food—while at the same time it soothes the body and enlivens the mind." I have quoted this, not because it is a reliable view of the part played by tea in the body, but because if I had stated simply the results of later experiments, some who have read Johnston's work might think I had overlooked so pronounced an opinion. For his opinion is based on a quite inadequate view of the case. Though tea diminishes tissue waste, it may nevertheless quicken the consumption of such foods as yield energy for work and heat. For if the reader will look back to p. 539 he will find that the urea cast out of the kidney is taken as a measure of tissue waste, and it is this that Johnston refers to, while the carbonic acid gas given off by the lungs is the means of estimating the consumption of fats, starches and sugars for yielding energy, and this portion of the case he has entirely overlooked. Now Dr. E. Smith, subsequent to the publication of the opinion I have quoted, made a series of experiments to determine the effect of tea on the quantity of carbonic acid given off by the lungs. He found in every case that it was markedly increased, and in his paper, published in the *Philosophical Transactions* of 1859, he states the exact figures. Now this increase implies increased consumption in the body of the energy-yielding foods, fats, starches, &c. This is quite consistent with the admitted fact that tea quickens the movement of the heart and the rapidity of the breathing, and increases the amount of heat given off from the body by the gentle stimulus to perspiration. So that even though it diminishes the waste of tissue it increases the waste of fuel, so to speak, and the result of the whole is an actual need for more food. Dr. Smith sums up the case thus: "Hence, in reference to nutrition, we may say that tea increases waste, since *it promotes the transformation of food without supplying nutriment, and increases the loss of heat without supplying fuel*, and it is therefore specially adapted to the wants of those who usually eat too much, and after a full meal, when the process of assimilation should be quickened, but is less adapted to the poor and ill-fed, and during fasting." Tea is, then, to be regarded as a stimulant, but as in no sense fitted to act as or take the place of a food. As a stimulant, however, it is a most valuable agent. Its exhilarating effect, which leaves no after depression, and entitles it to the praise of cheering without inebriating, is most useful for those engaged in intellectual work, to drive off drowsiness, and aid in removing feelings of languor and fatigue. But it is just those excellent qualities that render it most liable to abuse, when people are led by them to resort to it in states of exhaustion, when what their bodies are demanding is supplies of nourishing food, and when its stimulating properties are used to hide for the time the inadequacy of a poor or improper meal. There can be no manner of doubt that the rapid growth of tea consumption among the poorer classes, among many of whom it is found as a constituent of every meal, is doing great harm to their physical well-being. For it is supplanting far more nourishing diets, than the ordinary tea, bread and butter and bacon, &c. can ever make, and its cheering properties prevent that fact being recognized. If the meal be otherwise plentiful and nourishing, there can be no objection to a cup of tea if such is desired, and taken thus as an adjunct to the morning and evening meal it is pleasant to most people. If it is taken too frequently, however, in too large quantities or too strong, the injurious effects of thein and tannin begin to show themselves in the nervousness and tremors or in the dyspeptic stomach of the tea-drinker to excess. These bad effects are more speedily observed in those who use green teas constantly.

As a stimulant, accelerating muscular movement, and as a restorative during fatigue, tea is highly spoken of by army medical officers and generals who have commanded in the field. Parkes says of it: "As an article of diet for soldiers tea is most useful. The hot infusion, like that of coffee, is potent against both heat and cold, is most useful in great fatigue, especially in hot climates, and also has a great purifying effect on water. Tea is so light, is so easily carried, and the infusion is so readily made, that it should form the drink *par excellence* of the soldier on service." There is also a belief that it lessens the susceptibility to malaria, but the evidence on this point is imperfect.

The influence of tea on digestion has been shown on p. 603. Its slowing effect is supposed to be due to the tannin, but Roberts believes it to be due to certain acids, and to be got rid of by adding a pinch of soda.

The best way to infuse tea is to pour boiling water over the leaves in a hot cup, cover with the saucer, and allow to stand from 3 to 5 minutes. The infusion is then poured off, and no further water should be poured on in the endeavour to extract more from the leaves. "The semi-exhausted leaves are thrown away; a connoisseur never ventures on a second brew." The infusion so prepared has the delicate aroma of the plant, but wants the body and "grip" that many people think as desirable in tea as in whisky. It is a method open also to the charge of extravagance. Soft water extracts more soluble materials than hard water, and it is always proper to soften hard water with a pinch of bicarbonate of soda before using it for tea.

Adulterations of Tea.—Attfield says that owing to the vigilance of the custom-house officials adulterated tea seldom or never gains access to Britain, and is rarely, if ever adulterated afterwards; the abolition of duty has also favoured this state of affairs, though, of course, very inferior qualities are sent to market still. Formerly, however, adulteration was extensive, leaves of other plants being used, and such foreign leaves are still found. The leaves of *Camellia Sasanqua* and *Chloranthus inconspicuus* were said to be used in China, and in this country willow, sloe, oak, valonia oak, plane, beech, elm, poplar, hawthorn, elm, and horse-chestnut leaves were used, treated with gum and catechu and coloured. These could be detected by softening and spreading out the leaves on glass slides and observing the character and direction of the veins in each leaf. The border of the tea leaf is serrated, the primary veins run out from the midrib nearly to the border, and then turn in, a distinct space between them and the border being left. Exhausted leaves treated with gum and colouring matter were also used, whose presence required an analysis to show their deficiency in thein and tannin. What the Chinese called lie-tea was also largely used to adulterate. It consisted of the sweepings of the tea-houses, tea-dust, mixed with sand and often the magnetic oxide of iron, and made up into different forms with a solution of starch, to imitate various kinds of tea, especially gunpowder. A lens shows their true characters, and when some of the lie-tea is put into hot water, the binding material is loosened, and the little masses fall to pieces, showing their real nature. Tea and especially green tea was also faced or coloured, Prussian blue, mixed with gypsum, indigo, &c., were used for this purpose, the colour being added in the roasting-pan. This was done to meet the demand for a uniform and prettier colour. The actual quantity of colour would be very little, a third or fourth of a grain of the colouring matter per ounce of tea, but was still an undesirable addition. It could be detected by shaking tea up with cold water and throwing it on a piece of muslin over a glass. The colour will pass through the muslin and settle in the bottom of the glass. The water is poured off, and the colouring matter obtained. Black-lead was also used for black teas. Dr. Hill Hassall says "It will be a satisfaction to learn that the great bulk of the ordinary black teas, the Congous and Souchongs, consumed in this country, are free from admixture with foreign leaves and all other adulteration. The foreign leaves, when employed, are found principally in very low-priced and much-broken teas, and in the lower qualities of black and green gunpowder teas."

Paraguay Tea or **Maté** is prepared from the leaves of Brazilian holly (*Ilex paraguayensis*), which are dried and roasted, the whole stem and branches being cut down for the purpose. During the roasting the peculiar flavour is developed as in tea and coffee. The stems, leaves, &c., are then pounded to coarse powder in pits dug in the earth, sorted, packed in bullock-skins and set in the sun to dry. There are various qualities of it sold, according as it consists mainly of new leaves and young shoots, or leaves without twigs and stalks, or large old leaves with twigs and fragments of wood. Maté contains on an average 1·3 per cent of thein, 16 per cent of tannin, and a very small fraction of aromatic oil.

For the preparation of the infusion boiling water is poured on a tea-spoonful of the powdered leaves in a cup, a little sugar is added, and the liquid is sucked through a reed called a "bombilla." It has a narcotic action on the nervous system, and seems also to possess restorative and refreshing properties, valuable after great fatigue. It is used very extensively in Peru, Paraguay and Brazil, and people become as addicted to it as opium-eaters to their drug.

Bohemian Tea is prepared in Bohemia from the leaf of the common *Gromwell* (*Lithospermum officinale*), of the borage order of plants. It is used for adulterating ordinary tea, but contains none of the active ingredients of ordinary tea.

Coffee is prepared from the seed-beans of the coffee plant, *Caffea arabica*, of the natural order Cinchonaceæ, the same order which yields the tree from which Peruvian bark, quinine, ipecacuanha, &c., are prepared. The tree is small, shrub-like (Fig. 265), and a native of Abyssinia. It was introduced into Arabia in the fifteenth century, and the first coffee-shop was opened in London in 1652. The plant is sown in nurseries, transplanted when six months old, comes into full bearing in three years, and bears under favourable circumstances for twenty years.

Fig. 265.—Coffee Plant (*Caffea arabica*).

It is now extensively cultivated in Arabia, Ceylon, the East and West Indies, Brazil, and Central America. The fruit of the coffee tree, "which presents a superficial resemblance to a red cherry," contains two seeds, from which the pulp and covering are stripped, and which are then dried. It requires roasting for the development of the powerful volatile and aromatic oil, which gives the coffee its flavour, and which is not present, as such. previous to roasting.

The composition of Coffee is given by Church as follows:—

Water	5·0	per cent.
Thein (Caffein)	0·6	,,
Tannin	4·0	,,
Nitrogenous	15·0	,,
Gum, Colouring Matter, &c., and other extractives	34·4	,,
Fibre	36·4	,,
Saline	4·6	,,

The contrast between the amount of thein and tannin in coffee and the amount in tea has been already commented on. The aromatic oil is in so infinitesimal quantity that it has not been mentioned in the above analysis. Yet though it is in so small a quantity as to be with difficulty estimated, one part in fifty thousand, it is in this that the commercial value of the coffee depends. If the oil could be bought for the purpose of imparting the flavour, so as to add to the value of coffees of inferior aroma, it would, according to Payen, be worth £100 sterling an ounce. This oil appears to be developed by roasting to a greater extent in old than in new beans. All kinds of coffee-beans improve in their flavour by keeping, the small Mocha berries ripening in three years, but it is said that the coffee-beans with poorest flavour will, if kept for a sufficiently long time, ten to fourteen years, acquire as good a flavour as the best.

In the process of roasting, the berries swell and lose weight, 112 pounds of raw coffee being reduced to 92 pounds of roasted coffee. A chestnut-brown colour should be produced by roasting, a burnt flavour being produced when the process is overdone. Roasted coffee loses its aroma, if exposed to the air, and this it will do completely in two to four months. The coffee-drinker always prefers his coffee freshly roasted and ground. The infusion may be prepared much as tea is. Boiling drives off some of the aromatic oil, and makes the infusion deficient in flavour, while less than boiling does not extract from the ground coffee all that might be. It has, therefore, been recommended that the "grounds" from a previous infusion should be kept, that when a fresh supply of coffee is to be prepared, these "grounds" should be well boiled in water, and the hot decoction thus obtained poured over the fresh coffee, and be allowed to stand for from five to fifteen minutes, and then poured off, the "grounds" of this being retained for the next infusion. Thus both body and flavour would be secured. Coffee yields more extractives to soft than to hard water; to the latter a pinch of bicarbonate of soda should be added.

Constituents of a Breakfast-cupful of Coffee with ¾ oz. of Cream and ¼ oz. Sugar.

	Grains.
Cheesy matter from the cream	7½
Fat with sugar from milk and from seed	41
Added sugar	140
Extract from coffee seed (mineral 11; organic 41)	52
Mineral matter in cream	1½
Total	242

The action of coffee upon the body is similar to that of tea. It does not supply any nutriment worth considering, as the table showing the constituents of a cup of coffee indicates. Containing as it does less thein, more can be consumed than of tea, and the marked decrease in the amount of tannin renders it less liable to interfere with digestion. It was supposed that coffee diminished tissue change, as had also been alleged of tea. This has been shown to be inaccurate. It acts as a stimulant upon the nervous system, and upon the heart, and it increases the rate of breathing, and the amount of carbonic acid expelled. It acts also upon the kidneys, increasing the amount of water expelled by these organs. It tends also to produce a relaxing effect upon the bowels, while the effect of tea is rather binding. The active principle, thein or caffein, is an excellent remedy for nervous headache, given in from 1 to 3 grain doses. In excessive doses coffee acts injuriously upon the nervous system as does tea, producing brain excitement, nervous tremors, and wakefulness.

Coffee is especially useful during fatigue, as it invigorates without producing depression later; and it has marked power in relieving the feeling of hunger. It readily induces indigestion in the case of the dyspeptic, but not so readily as tea. Its stimulating effects are very useful in opium-poisoning, in nervous headache, and in other conditions. It often relieves the spasm of asthma.

Chicory is commonly added to coffee to give it increased "body." This is the root of the wild succory or wild endive (*Cichorium Intybus*), belonging to the natural order Compositæ, as do the dandelion and lettuce. It is extensively cultivated in Germany, Holland, and Belgium for this purpose. It grows wild in Britain, by the roadside, blossoming with pale-blue flowers in August and September, the stem rising from 1 to 3 feet in height. It has a long taproot like parsnip, white and fleshy, containing a milky bitter juice. The root is used before the blossoms are due, being cut into pieces, kiln-dried, roasted in revolving iron cylinders, with lard to the extent of 2 lbs. for every hundredweight of the dried root, and ground. Thus prepared it markedly resembles coffee, and contains a volatile oil giving aroma, but not of the character of the volatile oil of coffee, and it contains some bitter material, but no such tannic acid as is found in coffee and no caffein. It gives increased colour to coffee and strengthens the flavour, and its addition is desired by many people. In Germany it is much used, as much as 5 lbs. per head of the population being consumed in Belgium. It is not unwholesome, if used in small quantities, but it appears to act upon the bowels, tending to produce diarrhœa, and is apt to cause pain in the stomach, flatulence, &c. The presence of chicory in coffee can be detected by pouring some of the coffee on *cold* water in a wine-glass. Coffee floats for a long time, whereas chicory sinks at once. Moreover, coffee does not colour cold water, and chicory does.

Chicory is itself adulterated, roasted corn, wheat, beans, acorns, mangold-wurzel, dandelion-root, and various red earths being used for this purpose.

Coffee leaves have long been used in the Eastern Archipelago to yield a kind of tea. The leaves are roasted over a clear fire, then separated from the twigs, from which, after a second roasting, the bark is removed and mixed with the leaves. They make a clear brown infusion, which is drunk with cream and sugar like tea, and have a fragrant odour resembling a mixture of tea and coffee. In Sumatra this forms "the only beverage of the whole population," being preferred to the infusion of the berry. The leaves contain 1½ per cent of thein, as well as a volatile oil, and some astringent substance. According to Dr. E. Smith, the infusion does not excite either the pulse or breathing, but decreases both; and he accordingly thinks there is no probability of them supplanting either tea or coffee in the duty they perform in the human body.

Cocoa (Fig. 266) is the seed of a tree, the *Theobroma Cacao*, native to Mexico, West Indies, and South America, and it is chiefly grown in Brazil, Guiana, and Trinidad. Forests of it are grown in Demerara; it belongs to the natural order Byttneriaceæ. The fruit of the tree is of the shape of a small cucumber, and contains a sweetish pulp, in which 50 to 100 seeds are imbedded, arranged in rows, with partitions between them. The ripe fruit is collected in heaps on the ground or in earthen vessels, during which it undergoes a fermentive change, which develops an aromatic smell, and becomes soft. The seeds are then removed, cleaned, and dried in the sun. They are dark-brown in colour, and almond shaped. For use they are roasted in

Fig. 266.—Cocoa (*Theobroma Cacao*).

iron cylinders, which develops the aroma. Deprived of the husks and simply crushed, they form **cocoa-nibs**, the purest kind of cocoa obtainable. The bean, after roasting, is also crushed under hot rollers, mixed with sugar and flavouring materials, and formed into a paste, called **chocolate**. Or the ground cocoa is mixed with sugar, starch, or other ingredients, and sold as soluble cocoa, rock cocoa and flake cocoa being produced in a similar way. In the inferior cocoas there is some of the husk, ground down as finely as possible and added to the ground bean.

The composition of cocoa shows some very important differences from that of tea and coffee.

Water	6·0
Theobromin	1·5
Fat (Cocoa Butter)	50·0
Starch	10·0
Albuminous	18·0
Gum	8·0
Colouring Matter	2·6
Fibre, &c.	0·3
Saline	3·6

Of the above constituents the most notable are the theobromin and fat. The former has been already noticed, in considering thein, &c. (p. 654). There is no statement of aromatic oil or tannin, the quantities of these substances being excessively minute. The remarkable feature is the large quantity of fat, cocoa-butter, or oil of theobromin. It is about the consistency of tallow, yellowish-white, with the marked odour of chocolate, and a pleasant taste. It keeps for any length of time, when pure, always retaining its agreeable odour, and on this account it is used by druggists as a basis for suppositories.

Value of Cocoa.—The fat, as well as the albuminous, gummy and starchy constituents, make cocoa highly valuable as a food-stuff. For it is to be remembered that the preparation of cocoa for use is of a different kind from tea or coffee. If an infusion only were used, as is the case with the latter, these constituents would be of as little importance as the albuminoids of tea and coffee. But it is not an infusion that is employed, but a simple mixture with water, so that the whole of the ground cocoa is introduced into the body. This is a point of very great importance. When it is duly considered it is evident that cocoa possesses a very high value as a food-stuff. Reference to the table shows that no less than 86 per cent is of value for the repair of tissue or the liberation of energy, the high value of fat for the latter being borne in mind. About 14 ounces of each pound consists of useful material. It is indeed a food rather than a beverage; but, at the same time, the theobromin and minute quantity of aromatic oil give it qualities of a stimulating, fatigue-removing, and invigorating character, similar in character to, though not so pronounced in amount as, those of tea and coffee. It is to be noticed, however, that the nibs are used in a way to produce rather an infusion with properties like tea or coffee. They are gently boiled in water for a couple of hours, the liquid portion is then poured off, and the undissolved parts of the nibs thrown out. This method of preparation dissolves only part of the seed, and the beverage produced falls far short, in nutritive qualities, of the material made by mixing the cocoa ground to a fine powder with boiling water.

There is now in the market a very large number of prepared ground cocoas, of exceedingly delicate flavour and of great nutritive value—Van Houten's, Tulloch's Pure Dutch Cocoa, Fry's Pure Cocoa, and so on. It would be the greatest possible benefit to many if they would substitute cocoa for tea or coffee at least once a day.

The quantity of fat present in cocoa makes it feel rather heavy and somewhat difficult of digestion to many. Hence the manufacturers of prepared cocoa endeavour to reduce the quantity of fat, either simply by abstracting some of it and leaving the cocoa otherwise unaltered, which is the preferable way, or by diluting the cocoa with sugar, or starch, or other similar substance, various kinds of sugar and starches being employed for the purpose. In some of the cocoas in the market it is said there is not more than 30 per cent of pure cocoa, the rest being additions of sugar, starch, &c., with colouring matter. Such additions are, properly speaking, adulterations. To such prepared or diluted cocoas, where the dilution is acknowledged and its extent duly stated on the label, there is no serious objection, but they ought not to be sold under the name of pure cocoa, homeopathic cocoa, dietetic cocoa, or the like.

The adulteration of cocoa with arrow-root, potato starch, and other starches, can readily be detected by means of the microscope (see p. 598).

It may be remarked that if cocoa is diluted with sugar simply, the cocoa needs only the addition of boiling water; but if it has been diluted with starch, the simple addition of boiling water will not properly cook the starch, will not render it soluble, and such cocoa would be rendered more digestible by boiling for a few minutes.

The saline matters of cocoa consist chiefly of potash salts and phosphates.

Brazilian Cocoa, or **Guarana,** is derived from the seeds of a small climbing plant (*Paullinia sorbilis*) growing in Brazil, belonging to the natural order *Sapindaceæ,* or soap-worts. The seeds are dried, then roasted, powdered, and made into a stiff paste with water, being mixed with some of the whole and broken seeds, and pressed into cylindrical masses, not unlike sausages, and called **guarana-bread.** Pieces are broken from the rolls and infused in hot water, like tea or coffee, to form a beverage, which is sweetened, and is said to be as grateful and refreshing as either of the latter. The active principle of gaurana is called *guaranine,* but is identical with thein, and exists to the extent of five per cent in the guarana rolls, which also contain tannin, gum, &c. In short, the beverage presents marked resemblances in its active constituents and in its effects to both tea and coffee, being used as a nerve stimulant and restorative. Powdered guarana, as well as the active principle, are used in medicine as a nerve tonic, and the former, because of its astringent property, is employed for diarrhœa and dysentery. Powdered guarana in 30-grain doses is most valuable for sick headache (see p. 113). It is extensively used in Brazil, Costa Rica, and other parts of South America.

Coca, or **Cuca,** is not to be confounded with cocoa. Coca leaves are derived from a shrub found growing on the mountains of Bolivia and Peru, called *Erythroxylon coca.* The leaves are used very extensively by the natives, and in South America it is said the annual consumption of leaves cannot fall short of 100,000,000 pounds. The late Sir Robert Christison, of Edinburgh, was the first in this country to investigate the action of the drug, and the following gives some interesting detail of his experiments on himself:—"In the beginning of May, under a day temperature of 58°, I walked fifteen miles in four stages, with intervals of half an hour, at four-mile pace, without food or drink, after breakfast at half-past eight, and ending with a stage of six miles at half-past five in the afternoon. I had great difficulty in maintaining my pace through weariness towards the close, and was as effectually tired out as I remember ever to have been in my life, even after thirty miles at a stretch, forty or fifty years before. . . . The pulse, naturally 62 at rest, was 110 on my arrival at home, and two hours later it was still 90. I was unfit for mental work in the evening, but slept soundly all night, and awoke next morning somewhat wearied and disinclined for active exercise, although otherwise quite well. Two days afterwards I repeated this experiment, and obtained precisely the same results. . . . Four days later, with precisely the same dietary, I walked sixteen miles in three stages of four, six, and six miles, with one interval of half an hour and a second of an hour and a half. During the last forty-five minutes of the second rest I chewed thoroughly eighty grains of my best specimen of cuca, reserving forty grains more for use during the last stage. To make assurance doubly sure, I swallowed the exhausted fibre, which was my only difficulty. On completing the previous ten miles, I was fagged enough to look forward to the remaining six miles with considerable reluctance. I did not observe any sensible effect from the cuca till I got out of doors and put on my usual pace, when at once I was surprised to find that all sense of weariness had entirely fled, and that I could proceed not only with ease, but even with elasticity. I got over the six miles in an hour and a half without difficulty, found it easy when done to get up a four-and-a-half-mile pace, and to ascend quickly two steps at a time to my dressing-room, two floors up stairs; in short, had no sense of fatigue or other uneasiness whatsoever. On arrival at home the pulse was 90, and in two hours had fallen to 72. . . . Before dinner I felt neither hunger nor thirst, after complete abstinence from food and drink of every kind for nine hours; but on dinner appearing in half an hour, ample justice was done to it. Throughout the evening I was alert, and free from all drowsiness. Two hours of restlessness on going to bed I ascribed to the dose of two drachms being rather large; and after that I slept soundly, and awoke in the morning quite refreshed and free from all sense of fatigue and from all other uneasiness."

It is right to say, however, that every experimenter has not obtained such satisfactory results as Sir Robert Christison, though there is some reason for believing that failure is due to fresh leaves not being used, as there seems no doubt coca spoils with keeping.

Coca appears then to act somewhat like tea and coffee, stimulating the nervous system and lessening fatigue, for which purpose it is used by the Indians in Peru on long marches.

Coca yields an alkaloid, *cocaine,* which has the remarkable property of abolishing the sensibility of the skin and mucous membrane. Thus when a solution is applied to the tongue or throat, sensation is abolished in a few minutes,

taste being in abeyance for some time. A couple of drops instilled into the eye will in a few minutes destroy sensation there, so that an operation may be conducted without pain. Sensation returns again after the lapse of some hours.

Kola-nut is the fruit of a tree, *Sterculia acuminata*, indigenous to Central Africa. The roasted nut is used to yield an infusion, employed by the inhabitants of Central Africa much as tea and coffee are. It contains fully 2·3 per cent of caffein, also 0·023 per cent of theobromin, and fully 1·6 per cent of tannin. An extract called *kolatina*, to be used like cocoa, is now to be had, and is said to be a stimulating beverage, having no bad effects upon the digestion.

ALCOHOLIC DRINKS.

Alcoholic drinks embrace a great variety of beverages, ardent spirits, wines, malt liquors, and so on. These all possess in common the one great feature of containing in greater or smaller quantity the spirit of wine or alcohol; and it will be well if we first of all consider what alcohol is, how it is obtained, and what are its effects upon the body. This will afford a basis for considering the characters and effects of the various liquors in which it forms an ingredient.

Alcohols.

Composition of Alcohol.—Alcohol is a word derived from Arabic, and implies anything very subtle. It was a term originally applied only to the spirit distilled from wine, and meant simply the spirit of wine. Chemists investigated its chemical character, and found it to be a definite compound of carbon hydrogen and oxygen, in certain proportions, namely, two combining weights of carbon, six of hydrogen, and one of oxygen; and thus alcohol was represented by the chemical formula C_2H_6O, expressive of the elements entering into the composition of alcohol, and the proportions in which they combined. It was then found that there was a series of substances, related to this spirit of wine from a chemical point of view, formed of the same elements in other proportions, and this series of substances came to be classed together as alcohols. The most commonly known of these substances are:—

Methylic alcohol or wood spirit or wood naphtha (CH_4O).
Ethylic alcohol or spirit of wine (C_2H_6O).
Amylic alcohol or potato spirit or fousel-oil ($C_5H_{12}O$).

Methylic alcohol is obtained by the destructive distillation of wood. Methylated spirit is ordinary alcohol, spirit of wine, to which this wood spirit is added, to prevent it being used for drinking purposes, and thus permit it being used for commercial purposes at a cheap rate. Amylic alcohol or potato spirit is usually produced in the processes of fermentation by which ordinary alcohol is obtained. It is the presence of this potato spirit in whisky which gives its peaty smell and burning taste. There is a large number of other alcohols, propylic, butylic, caproic, caprylic alcohols, and so on, many of which are produced in the fermentation of sugar along with ordinary alcohol, giving peculiar characters to the fermented liquor. It is, however, with ethylic alcohol, or spirit of wine, which is the one commonly meant when one speaks of alcohol, it is with it we have to do.

Preparation of Alcohol.—The ordinary alcohol with which everyone is familiar is produced in solutions containing sugar by a process of fermentation. This process is due to the activity in the solution of a little organism, the yeast plant. It is a single cell (Fig. 267), round

Fig. 267.—Yeast Cells (ferment) growing during forty-eight hours: (*a*) magnified 200, and (*b*) 400 diameters. After Beale.

or oval, measuring in its greatest diameter on an average about $\frac{1}{3000}$th of an inch, some larger and some smaller. Each little cell is an independent organism, capable of living and, unaided, reproducing its kind. This latter it accomplishes by budding. A minute prominence appears at some part of the surface of the cell, enlarges, and finally attains a size nearly equal to that of the mother cell. The connection between the two becomes narrowed, and finally the young cell separates and becomes an independent organism, speedily throwing off buds itself. The cells thus multiply in a suitable medium with enormous rapidity. Let any one who owns a microscope take a minute speck of brewer's yeast on a glass slide, place on it a drop of water, mix the two, cover with a cover-glass, and examine under a lens magnifying by 300 diameters, and he will see hundreds of such bodies as are depicted in Fig. 267. Now when such yeast is sown in a sugary solution, let us say in the juice expressed from ripe grapes, it proceeds to multiply with great rapidity. It does so at the expense of the

solution, and as an absolutely necessary part of its vital operations, it produces chemical changes in the sugary solution. The sugar, which consists of carbon, hydrogen, and oxygen, is split up into two different substances, part of the carbon going with part of the oxygen to form carbonic acid gas (CO_2), and the remainder of the carbon going with hydrogen and oxygen to form alcohol (C_2H_6O). Sugar disappears, that is to say, and alcohol and carbonic acid gas take its place, produced from it by the activity of the yeast plant. Thus it is that if anyone sows yeast in a sugary solution and keeps it at a moderate temperature, minute bubbles of gas will be seen rising in great numbers, bubbles of the carbonic acid gas escaping, and alcohol will have been produced in the solution. Very many most elaborate researches have been made by the most distinguished chemists, such as Lavoisier, Gay-Lussac, Thénard, De Saussure, and Pasteur, to determine whether the quantity of carbon, hydrogen, and oxygen in the sugar which disappeared could be accounted for in the quantity of alcohol and carbonic acid gas produced, with the result of obtaining almost exact correspondence. Thus 105·26 parts of grape-sugar (equal to 100 parts of cane-sugar) have been found to yield:—

Alcohol	51·11 parts.
Carbonic Acid Gas	48·89 „

which, along with 5·26 parts of other substances formed in course of the fermentation, such as glycerine, succinic acid, and a small proportion united with the yeast, make up the 105·26 parts of grape-sugar.

Alcohol then is produced by the agency of a living organism from the decomposition of sugar. One pound of sugar yields rather over ½ lb. of proof spirit, or over ¼ lb. absolute alcohol. It is only, however, from sugars capable of fermentation that alcohol is produced *directly*. Such sugars are grape-sugar, in particular, found in many vegetable juices, muscle-sugar or inosite and other similar sugars, already noted on p. 587. Cane-sugar, beetroot-sugar, and milk-sugar are not capable of immediate fermentation, but can be converted into grape-sugar by various means and then made to yield spirit. Moreover, we have seen that starch is capable of conversion into sugar by the agency of various ferments, and is so converted in the body by the action of saliva (p. 143) and pancreatic juice (p. 145) as a necessary part of the process of digestion. Further, we have noted that the starch so richly present in wheat may be converted into sugar by the action of a ferment, present in the wheat grain itself (p. 559), that the starch of the barley grain is also convertible into sugar by a ferment present in the barley, produced in the grain in the process of germination, and that it is only necessary to place the grain in circumstances of heat and moisture for that process of conversion to proceed. Hence it follows that when such conversion is achieved it is only needful further to add some yeast, to set agoing the second process by which alcohol will be produced. Starch may be converted into sugar by chemical means, by boiling with sulphuric acid, and it is grape-sugar that is thus formed. It is evident, therefore, that any substance whatever which contains either sugar or starch can by the appropriate means be made to yield alcohol. So not only fruits like grapes, and vegetables like turnips and potatoes, but an infinite variety of incongruous substances, old paper, dusty legal parchments, raw cotton and flax, rags, and even sawdust can be made to yield alcohol. The quantity of starch or sugar in these latter substances is, however, too small to permit of alcohol being manufactured from them except at great cost. Hence in the production of alcohol the cereals which contain starch in large quantity, barley, &c., are commonly used. Potatoes, also rich in starch, are largely used on the continent of Europe to yield an inferior spirit—potato brandy. 100 lbs. of corn yield nearly 3½ gallons proof spirit, and one bushel of malted barley produces, on an average, 2 gallons of spirit; while 100 lbs. of starch yields 70 lbs. sugar, and that yields 8 gallons proof spirit.

Though it was known in very early times that vegetable juices like that of the grape, if allowed to ferment, underwent some change by which an intoxicating character was produced, the real substance—the spirit—to which this was due was not known by itself, and was not separated from the wine till the twelfth century, when Abucasis, by a process of distillation, was able to separate it. Hence the name, spirit of wine, given to it.

The method of producing whisky will illustrate the various processes in the preparation of alcohol. For the manufacture of whisky barley is employed. It contains (p. 558) fully 65½ per cent of starch. The whisky manufacturer has therefore three processes to conduct: (1) he must get the starch converted into grape-sugar, and obtain this in solution, (2) he must excite in the sugary solution the alcoholic fermentation, and cause it to be maintained till all the sugar

is converted into alcohol and carbonic acid gas, (3) he must then separate out the produced spirit. The first process is called **malting the grain**, and the solution obtained is called the **wort**, the second process is the **fermentation of the wort**, and the third process is that of **distillation.** The barley is first steeped in water till the grains are well swollen. After being drained it is spread out on the floors of the malt-house, when germination begins and much heat is developed. The germination is allowed to proceed till the germ (acrospire) is about to burst the seed coat, which occurs in from fourteen to twenty-one days. At this stage further sprouting is stopped by the grain being dried in a kiln. The changed grain is now called malt, and is of a pale, amber, or dark colour according to the heat applied in drying. Malt differs from barley in containing a small proportion of sugar, and specially in containing a ferment, called **diastase,** which did not previously exist in the barley grain, but is produced in the course of germination. Now this diastase possesses the property of converting starch into grape-sugar with great rapidity. Accordingly the next business of the whisky manufacturer is to place the malt in such circumstances that the diastase will have free opportunity of performing its task. Accordingly the malt is bruised and placed in a large vessel called a mash-tun, water at a temperature of from 157° to 160° Fahr. being mixed with it. The water dissolves the sugar already present in the malt, as well as the diastase, which thus gets ready access to the starch of the malt, and the conversion into sugar proceeds with great rapidity. In a few hours it will be complete. So active is diastase that 1 part can convert 200,000 of starch. "Thus 100 parts of starch made into a paste with 39 times its weight of water, and mixed with 6·13 parts of diastase in 40 parts of water, produced 86·9 parts of sugar in one hour" (Smith). The activity of the ferment is so great that it is capable of converting a much larger quantity of starch into sugar than is actually present in the grain. On this account it is common to add to the mash-tun unmalted grain, or starch derived from other sources such as potatoes. By this means the trouble of malting a considerable amount of grain is saved, as well as an actual loss of substance; for in the malting process there is a loss of solid matter of the barley to the extent of thirteen per cent. Whisky thus produced has, however, a harsher and less agreeable flavour than that entirely obtained from malted grain, and is an inferior article. When the starch has all been converted into sugar, the sweet wort, as the infusion is called, is boiled to destroy the diastase. The boiled liquor is then run off, cooled, and transferred to the fermenting tun, where yeast is added, and allowed to act till all the sugar has been split up into alcohol and carbonic acid gas. In the final process the fermented liquor is placed in a vessel called a still, set over a fire. From the dome-shaped cover of the still passes a tube, which proceeds in a spiral fashion, and is hence called a worm, through a vessel which contains cold water. The heat raises the alcohol as vapour, and in passing through the worm, it is condensed and caught in the receiver. The alcohol passes over along with a considerable quantity of watery vapour, and pure alcohol is not immediately obtained. What is obtained by the first distillation may be again distilled, and again and again, but even when repeatedly redistilled, the spirit still contains about 9 per cent of water, which can only be got rid off by other means. Moreover, not only water passes over with the alcohol, but also the vapour of other substances produced in the wort. The nature of these other substances depends upon the source of the spirit, grape-juice, barley, rye, &c., and it is their presence which gives to the spirit its peculiar character and flavour. Thus acetic acid and fousel-oil are usually present in small quantities.

Rectified Spirit is spirit from which all impurities, such as fousel-oil and acetic acid, have been removed by redistillation and other means. But, as already said, the most highly rectified spirit still contains 9 per cent of water.

Absolute Alcohol is the term applied to perfectly pure alcohol, from which all the water as well as other impurities have been removed. It is transparent and quite colourless; "has an enlivening odour and a burning taste." It is lighter than water. At a temperature of 68° Fahr., a vessel which will hold 1000 grains of water will, if filled with absolute alcohol, weigh 208 grains less, that is its specific gravity is only 792, that of water being taken as 1000.

Proof Spirit is the proportion of spirit and water allowed by act of parliament for excise purposes. It is said to consist of:—

Alcohol (by weight)	49·24
Water (by weight)	50·76

in 100 parts (by weight) of proof spirit. Spirits weaker than this are said to be under proof, and stronger than this are said to be over proof.

Fifty over proof means that the strength of the spirit is such that to every 100 parts of the spirit 50 parts of water would require to be added to reduce the strength to proof; or if the spirits be 20 over proof, 20 parts of water need to be added to every 100 parts of the spirits to bring them down to proof. On the other hand 30 under proof would mean that every 100 parts of the spirits contained only 70 parts proof spirit and 30 of water.

Proportion of alcohol in various spirits, wines, &c.—The proportion of pure alcohol by volume in the various spirits, wines, &c. in common use is shown in the following table:—

Brandy	55·39 per cent.
Whisky (Scotch)	54·32 ,,
Whisky (Irish)	53·20 ,,
Rum	53·68 ,,
Gin	51·60 ,,
Port Wine	20·25 ,,
Sherry Wine	16·30 ,,
Madeira Wine	16·10 ,,
Claret and Hock	8 to 13 ,,
Champagne	7 to 12 ,,
Edinburgh Ale	5 to 6 ,,
Porter	5 to 7 ,,
Lager Beer	5·1 ,,
Cider (average)	6·0 ,,
Gooseberry Wine	3·0 ,,
Ginger Wine	1 to 6 ,,

Brandy is prepared by distilling wine, or at least ought to be so prepared; 1000 gallons of wine yield from 100 to 150 gallons of brandy, containing from 50 to 54 per cent of absolute alcohol. Its quality varies with the wine from which it is prepared. The most delicate is yielded by white wine, and the white wines of the Cognac and Armagnac districts of France are specially prized for the purpose. Inferior wines are used to obtain cheaper qualities of brandy; poor qualities are produced from the refuse of grapes, wine-presses and wine casks, being made up with other substances. Much alcohol sold as brandy is simply spirit obtained by the fermentation of sugar, as in the preparation of whisky, coloured with burnt sugar and flavoured. Thus the fiery spirit produced in Germany from potato starch is, after redistillation in France and colouring, sent over to Britain as brandy. Brandy when produced is colourless, and obtains its dark hue from keeping in oak casks. "The brandy made in England is for the most part artificial. A very usual process is to add to every 100 parts of proof spirit from half a pound to a pound of argol [the tartar from the inside of wine casks] some bruised French plums, and a quart of good Cognac; the mixture is then distilled, and a little acetic ether, tannin and burnt sugar added afterwards" (Blyth).

The peculiar flavour of brandy is derived from the wine from which it is distilled, and depends on various volatile oils and œnanthic ethers, which pass over with the spirit in course of distillation. Some of these are also produced by slow chemical changes of the nature of oxidation, changes which go on in the brandy if it is kept long, and which also vary with the original quality of the spirit. Thus brandy contains besides alcohol and water, acetic, œnanthic, butyric, and valerianic ethers, small quantities of grape-sugar, minute quantities of a volatile oil, colouring matter, a trace of tannin, acetic acid, and a little fixed acid. Old brandy is characterized by the presence of these various ethers, to which the special flavour is due.

Whisky.—Whisky is prepared from malted barley, or often a mixture of malted barley and raw grain as is common in Ireland. It also contains various volatile oils which pass over in distillation. It also is improved by age, harshness and fieriness being mellowed thereby. The peaty flavour is said to be due to the peat or turf fires over which the malt is dried. But one ingredient, almost commonly present, confers a peaty taste, namely fousel-oil or potato spirit. A small quantity is produced in course of manufacture, but it is sometimes added as an adulteration, being cheaply prepared. It is this which gives the fiery taste to crude spirits; and it is an injurious ingredient, producing headache and giddiness, from which men engaged in the production of potato spirit suffer, unless some arrangement exists for preventing inhalation of the fumes. Whisky is by preference kept in sherry casks to acquire colour and flavour. Whisky also contains some acetic acid, but should contain no sugar.

Rum is the spirit distilled from molasses which have been allowed to ferment. It is coloured with caramel. It is a West Indian product, where molasses, skimmings from sugar-boilers, &c. are mixed with water and distilled after fermentation. Poor qualities are prepared from the waste of sugar-cane. In France it is also manufactured from the skimmings, &c. of the beet-sugar factories. The finest qualities are rich in volatile and essential oils, and by keeping it acquires a very soft mellow flavour. It may also contain a small quantity of sugar and acid. To every 6 cwt. of sugar produced on a plantation there is usually also 1 gallon of rum.

Rum which, by age, has lost in alcoholic strength and gained in flavour by the development of œnanthic ether is, according to Dr. Ed. Smith, the purest and most healthful member of the spirit class, and the most perfect cordial with which we are acquainted.

Gin is entirely a prepared spirit, made up usually of an inferior alcohol, distilled from barley malt and unmalted rye, and apt to contain a considerable proportion of fousel-oil, and flavoured by means of various substances, specially juniper berries, coriander seeds, orris root, angelica root, grains of paradise, cardamom seeds, cassia buds, turpentine, creasote, &c. The name gin is derived from Genièvre, French for the juniper, and this supplied the term Geneva by which it is sometimes called, which became corrupted to gin. It was at first imported from Holland only, and thus went under the name "hollands." "Cordial gin," or "Old Tom," is the same article sweetened. The juniper berries give it diuretic properties, that is cause it to act upon the kidneys, so as to increase the quantity of water passed. After the spirit has been distilled over from the fermented grain, it is submitted to a redistillation for the purpose of rectifying it. It is at this stage the juniper berries and other materials are added, the redistillation then proceeding. Each distiller usually has a mixture of flavouring ingredients of his own liking.

Arrack is the distilled spirit of the fermented juice of the cocoa-nut tree, and is obtained also from palm-wine (see p. 581). It is also distilled from fermented rice liquor. It contains usually 52·7 per cent of alcohol, and it is largely consumed by the Hindoos and Malays.

Liqueurs or **Cordials** are strong spirits, usually highly sweetened, and flavoured by various fruity or aromatic substances. They are also commonly brightly coloured by means of cochineal, turmeric, &c. They are used to stimulate digestion, and are taken in small quantities at the end of dinner.

Absinthe is flavoured with the oil of wormwood (*Artemisia Absinthium*), and with peppermint, angelica, cloves, cinnamon, and aniseed. It is coloured green by vegetable juices. It contains 50 per cent of alcohol, and 1½ of sugar. The oil of wormwood is present to the extent of ⅓rd per cent. The oil of wormwood has a poisonous action on the nervous system, and absinthe is said to be "one of the most treacherous and pernicious for habitual use of all the liquids of the alcoholic class" (Pavy).

Curaçoa is a liquor containing 47 per cent alcohol, 28½ per cent cane-sugar, and is flavoured with orange peel.

Benedictine has 44 per cent alcohol and 32½ of cane-sugar.

Noyeau is flavoured with the kernels of peach, apricot, bitter almonds or cherry. It is cherries which flavour **Maraschino** and **Kirschwasser.** The latter is distilled from the fermented juice of bruised cherries, in which the kernels of the stones have been kept. **Chartreuse** has a flavouring of angelica oil and a peculiar kind of turpentine.

The Effects of Alcohol on the Body and Its Value.—Is Alcohol a Food? On the answer to this question largely depends the estimate one will form of the value of alcoholic drinks to the body. What the meaning of that question is, no one, who has read the early pages of this section with any understanding, ought to have any difficulty in apprehending. Does it yield up anything to the body for the repair of tear and wear of tissue? or does it undergo combustion in the body to yield energy for heat and work? These are the two parts of the same question. It consists of carbon hydrogen and oxygen only, and the absence of nitrogen at once settles the question of its power to aid directly in the repair of wasted tissue, but its carbon and hydrogen are capable of combustion. From such chemical considerations Liebig came to the conclusion that it was a respiratory food, that its carbon and hydrogen underwent combustion to carbonic acid gas and water, yielding energy for heat. "Of all respiratory matters," he says, "alcohol acts most rapidly." . . . "Alcohol stands high as a respiratory material. Its use enables us to dispense with the starch and sugar of our food, and is irreconcilable with that of fat." Later than this, researches undertaken by certain French investigators, Lallemand, Duroy, and Perrin, went to show that Liebig had been mistaken. Their experiments seemed to show that alcohol, taken into the body, passed through it *unchanged;* and their conclusions were based upon the fact that shortly after alcohol had been taken, it could be detected escaping by the breath, the urine, and the skin; and could be so detected for many hours. They therefore concluded that it was all given off from the body as alcohol. If this were so, it is obvious it could not be considered a food, for it could not undergo oxidation for the liberation of energy for either heat or work. They therefore stated that it was not in any sense a food. These results were confirmed by Dr. Edward Smith, who detected alcohol in the

breath four hours after $1\frac{1}{2}$ oz. had been taken. It was shown, however, by Dr. Anstie (1864), and in the preceding year by M. Baudot, that although it was quite true that alcohol can be detected as such in the breath, sweat, and urine for many hours after alcohol has been taken in any quantity, yet the quantity so cast off from the body is only a very small fraction of what has been consumed. Dr. Anstie showed that the tests employed were extremely delicate, and would indicate the presence of alcohol, even though only a very minute quantity escaped from the body unaltered. These results were corroborated in 1872 by Dr. A. Dupré, who found that only a minute fraction of the amount of alcohol taken was cast off as such in the breath, sweat, &c., and that the greater portion was retained and destroyed in the body. What changes it undergoes is not known, but it is thought to be a reasonable conclusion that it undergoes oxidation, and sooner or later is used for the liberation of energy as work or heat. Dr. Parkes, however, inclines to the view that it becomes changed simply to acetic acid, and that it might subsequently unite with the soda of the blood, finally being expelled in the urine in the form of a carbonate. "If this view is correct," he says, "the use of alcohol in nutrition would be limited to the effects it produces, first as alcohol, and subsequently as acetic acid, when it neutralizes soda, and is then changed into carbonate."

On the whole the present generally accepted view is that alcohol does take rank as a food, undergoing changes in the body leading to the liberation of energy. There is also some more or less valuable evidence that alcohol can replace food to some extent, that if the food is insufficient for the bodily wants, the addition of a small quantity of alcohol will remedy the deficiency. Thus Dr. Anstie relates a number of very remarkable cases, not of persons suffering from disease only, but also of persons otherwise healthy, who regularly took an amount of food utterly insufficient for bodily purposes, and along with it a considerable supply of alcohol, and who did not exhibit any of the signs of emaciation and prostration that would be expected, in whom, that is to say, alcohol took the place of food. These cases, however, are so remarkable that Dr. Anstie hardly offers sufficient proof of their entire credibility. Dr. Hammond, however, an American physiologist, made a direct experiment of this kind upon himself. He took for sometime an insufficient diet, and found he was daily losing weight upon it. He then added to it only a small proportion of alcohol and, thereupon, found that he not only ceased to lose weight, but actually converted the loss into a gain. For such reasons the conclusion indicated has been arrived at, that alcohol is able to a certain extent to take the place of a certain amount of the necessary daily quantity of food.

There is another way in which it appears alcohol may affect the nutrition of the body. It appears certain that alcohol diminishes oxidation changes going on in the body. It diminishes combustion, the consumption of material going on in the body. This is effected by lessening the rate at which the blood gives up oxygen to the tissues, and as oxidation cannot go on in the body without the proper supply of oxygen any more than a fire can burn without a proper supply of air (see p. 527), so this lessening of the amount of oxygen to the tissues diminishes the tissue waste. Such a diminution of combustion is not a desirable thing in a state of health. It implies an interference with the natural processes of the bodily economy, and a lessened liberation of energy for work. It may be, and very often is, a most desirable result to obtain in a state of disease; but it is scarcely correct to call alcohol a food because of this effect. It is, on this account, rather a drug, such as quinine which exerts a similar influence. It is probable that the fattening effect of alcohol, the tendency to an unhealthy deposition of fat in persons who drink considerable quantities of alcoholic liquors, is due to this result of diminished oxidation. In particular this is noticeable in those who drink largely of malt liquors, in which there is present sugar to a greater or less extent. The consumption of this, as well as of sugars and fats in the food, being prevented, it is converted into fat and deposited. Moreover it is a well-known tendency of alcohol, when used to excess, to produce fatty degeneration of various organs of the body.

Setting aside, however, this fact of the diminished oxidation due to alcohol, as being, on the whole, prejudicial in a state of health, however useful in disease, and as not justifying the description of alcohol as a food, and accepting the view that it can besides undergo combustion in the body to yield energy, and, on this account, to be rightly reckoned to some extent as a food-stuff, the question that next arises is to what extent does alcohol become useful, in a state of health, in virtue of its latter property? Supposing it to be admitted to the class of energy-yielding foods, may it be employed to

any extent as such? Supposing enough of albuminous foods, such as beef, eggs, fish, &c., be given to supply waste of tissue, could alcohol be given in sufficient quantity to yield the needed energy for heat and work? This raises the question, What other effects does spirit of wine produce on the body which may limit or impair its use as a food? In the following paragraphs an answer to this very wide question will be attempted, in the light of the most recent researches on the subject.

The Effects of Alcohol on the Body.—In general alcohol produces two kinds of effects, apparently very different from one another, dependent upon the quantity taken. In small doses it is a general stimulant, in large doses it is a narcotic poison. Here, at once, we are face to face with the broad fact that if alcohol is entitled to be classed as an energy-yielding food, its usefulness as such is strictly limited. Abundant illustration might be given of these two kinds of action. To an old person with enfeebled digestion a small quantity of brandy and water or whisky and water, given with food, enables the meal to be digested more easily. This is probably because the *slight* irritant effect upon the stomach, akin to the glow experienced in the mouth with the contact of the spirit and water, brings a larger supply of blood to the lining membrane and an increased flow of gastric juice from the stomach glands for digestive purposes. But if the dose is excessive, the irritation becomes so great that stimulation passes into paralysis, the quantity of digestive fluid becomes diminished, thick, and inactive, and perhaps is arrested, and patches of congestion appear on the stomach wall. These effects Dr. Beaumont saw with his eyes produced in the stomach of St. Martin (p. 601), after excess. The result was arrested digestion, wholly or partially. When these effects are marked, instead of the keener relish for food and increased appetite following the use of the small quantity, there are the loathing for food or simply the loss of appetite, the uneasy sensations about the stomach, the parched mouth, sickness, vomiting, and so on, so well known to too many. But the noticeable feature is that Dr. Beaumont observed the paralysing effect upon the stomach before St. Martin had any sensations, intimating to him any interference with digestion.

The stimulating effect of small doses and the depressing and paralysing effect of large doses of alcohol are also produced on the heart and circulation. With small doses the heart beats more quickly and strongly, and the flow of blood is thereby quickened through the body, to the brain, the muscles, and the skin. Moreover, the blood-vessels dilate, and the blood flows more readily through them. Thus the face flushes, the arteries of the temple throb, the skin, pinched and wrinkled and blue with cold, becomes softer, fuller, and ruddier, and a feeling of glowing warmth takes the place of the miserable shrivelled feeling the cold had induced. This is the stimulating action on the heart and circulation. But a large dose produces enfeebled and irregular action of the heart, and it has been shown that both in animals and man a large dose of alcohol may kill immediately by sudden stoppage of the heart's action. This, however, is due to the shock produced by the entrance of the large quantity into the stomach, by reflex action (p. 86), that is to say on the heart, and not by the spirit acting on the heart through the blood, though after the lapse of a little time a large dose would produce a like effect, acting through the blood.

In the same way a stimulating or a paralysing action is produced on the brain and nervous system in general, according to the quantity of spirit consumed. The lively imagination, the rapid flow of ideas, the sharpened wit, the freer discourse, the more generous enthusiasm, or it may be the more combative and argumentative spirit, are some of the stimulating effects of alcohol upon the nervous system, partly due to the increased supply of blood, owing to the quickened circulation, but also due to the direct action of the alcohol, circulating in the blood, on the nerve-centres. But the more markedly this stimulating effect is produced, the more near is one to the commencing of the paralytic action, when the loss of self-restraint indicates that the higher centres are beginning to succumb. The unsteady gait or speech proclaims the loss of the power properly to co-ordinate muscular movements for definite purposes, and rambling remarks, confused and stupid appearance, tell that the higher faculties of the brain are under the paralysing influence of the alcohol. It is the higher nerve-centres, those of the brain, that first experience the narcotic effect; the nerve-centres of the spinal cord are all affected later. Thus a man who cannot keep his feet may yet keep his saddle, if he is accustomed to ride, because it is the lesser brain or cerebellum (p. 93) that regulates the combined muscular movements necessary for walking, and that function is largely in abeyance, while he keeps the saddle owing to a reflex action (p. 86), the

stimulus derived from the thighs in contact with the horse acting on the nerve-centres of the spinal cord, which the alcohol has not yet overpowered. Even when the narcotic action on the nervous system is so pronounced that the man lies "dead drunk," insensible to kicks or blows, every muscle relaxed and powerless, one part of the nervous system may yet remain less powerfully affected, the medulla oblongata (p. 93), in which are the nerve-centres maintaining the action of the heart and the movements of breathing. It is not unless the dose has been sufficient to abolish their action also that death results, and it is usually the cessation of breathing that determines death, the heart continuing to beat a brief time longer.

Well then, it may be said, alcohol is safe so long as one does not exceed the quantity that simply stimulates. This might be admitted if it were possible to mark the point where stimulation ceased and narcotic action began. It is not easy to determine such a point, because one follows so hard on the track of the other. The depressing action, indeed, is the direct consequence of a certain degree of stimulation; it is exhaustion produced by the alcohol having goaded the organ, the nerve-centres, let us say, into expending more energy than it could speedily replace. In different individuals, too, the proportion between the two effects is very variable. In one individual the stimulating effect is hardly noticeable, it is so short-lived, and only the depression is prominent, even a small dose producing bad effects, while another seems to be unaffected except by large quantities. Indeed it is a question whether the stimulating effect is not in some senses actually already a paralysing one. The increased flow of blood to the stomach may be because the contact of the spirit with the stomach wall has partly paralysed the finer blood-vessels, has diminished, that is to say, the tone of their walls, so that they become more flaccid and more readily yield to the pressure of blood within them. The apparent stimulus to the heart may be because already a slight paralysing action is being exerted upon the restraining nerve of the heart (the pneumogastric, p. 96) and the exciting nerve of the heart (the sympathetic, p. 225) is not being properly and healthily restrained. It is certainly the view that the flushing of the face and the manifest more ready flow of blood to the skin are due to a certain degree of paralysis of the nerves (the vasomotor nerves, p. 233), which control the size of the blood-vessels, and so the pressure of blood easily dilates the vessels. Undoubtedly this is the explanation of the persistent redness of the face, nose, &c., of those who habitually indulge; the blood-vessels have lost their tone by the continued action of the spirit. If, again, the alcohol seems to stimulate the nervous system, one must not overlook the fact that, though ideas and speech become more rapid, control of them is less effective, and the healthy restraining influence of the higher nerve-centres is lessened. There is undoubtedly good reason for believing that the apparent stimulating action may be only a slight paralysing action in disguise, and, if so, it cannot be useful for a man *in health*, however useful it may frequently be in cases of disease. It has further to be noted that well-marked remote effects follow the habitual use of alcohol, not only in large doses but also in small, and apparently, harmless doses if frequently repeated. A man may take, for example, a nip of whisky or brandy without any apparent or actual effect, but if he is regularly in the habit, in connection with business transactions, for example, to have sundry and frequent nips a-day, though not one seems to have any effect upon him, yet in time slow changes are set up in various bodily organs, which become evident, it may be, only after years of continuance of the practice. These slow changes are of the nature of a degeneration, fatty or fibrous. The true structure of the organ or organs affected undergoes fatty degeneration, such as the muscular fibre of the heart, or becomes transformed into a fibrous character, such as is exceedingly common in the liver, giving rise to what is called "gin-drinkers'" liver, and also in the kidneys. The brain and nervous system may also be similarly affected. Now a man may become thus affected as a consequence of frequently-repeated small doses of spirits, who has never been known to be intoxicated, and whose friends are prepared to certify as a "strictly temperate man."

It will be well at this stage to note particularly what is the general tenor of the conclusions we have reached. They are these:—

1. *Alcohol is to some extent used up in the body, and may, therefore, liberate energy for heat or work, so that in a limited sense it may be classed as an energy-yielding food.*
2. *If alcohol is employed beyond certain small doses, it has injurious effects of a paralytic kind upon various organs of the body.*

Thus the first conclusion is qualified in a very important way by the second, for a food-stuff

which, if used, except in small quantity, will have an injurious effect, is scarcely to be considered of value as a food-stuff at all, it is little more than a drug.

Supposing the remarks that have been made as to the difficulty of marking a line between one kind of effect of alcohol and another, the evidently poisonous effect—supposing these remarks to be accepted as indicating the impossibility of saying to anyone, "You may take a certain quantity of alcohol without fear of harm," the question may yet be asked is it not possible to lay down a limit beyond which injury is almost certain to arise? If one cannot say, "You are perfectly safe within a certain limit," it will be at least of some use if one can say, "You are certainly in danger beyond another limit." This both Dr. Anstie and Dr. Parkes and others have attempted to do. It has been said that alcohol appears in the urine, breath, and sweat, some time after a quantity has been consumed. An endeavour was made to find what quantity, if any, could be given to a healthy man in twenty-four hours, *without any appearing in the urine.* As soon as any began to appear in the urine, that was accepted as an indication that more had been introduced into the body than could be disposed of, and that the introduction of more could almost certainly be productive of no useful effect. Dr. Anstie found that when a quantity exceeding one ounce and a half of pure alcohol (absolute alcohol) was introduced, *not at one time, but in 24 hours,* the limit was passed. Dr. Parkes and Count Wollowicz corroborated this in a very remarkable way by finding that in strong healthy men, accustomed to alcohol in moderation, they observed the beginning of injurious effects when a quantity of spirit was introduced in 24 hours, which contained between one and one and a half ounces of absolute alcohol. "Assuming the correctness of these experimental data," says Parkes, "which, though not extensive, are yet apparently exact, it is evident that moderation must be *something below* the quantities mentioned; and, considering the dangers of taking excess of alcohol, it seems wisest to assume 1 to 1½ fluid ounces of absolute alcohol in twenty-four hours as the maximum amount which a healthy man should take." The meaning of absolute alcohol is explained on p. 666. It, of course, is not used at all as a drink, and one could consume varying quantities of the different alcoholic drinks, without exceeding the 1 ounce of absolute alcohol, according to the percentage of alcohol they contain. The quantities can be calculated from the table on p. 667, where the varying percentage is stated. If whisky contains, in round numbers, only 50 per cent absolute alcohol, obviously 2 ounces of whisky will yield 1 ounce of absolute alcohol. An ordinary wine-glass contains generally about 2½ ounces of whisky, that is half a gill, and that quantity is beyond the limit of safety. The following table shows the relative quantities of the different drinks:—

1 oz. absolute alcohol is contained in				2 ounces whisky;		
1 ,,	,,	,,	,,	5	,,	wines like sherry and port;
1 ,,	,,	,,	,,	10	,,	,, claret and hock;
1 ,,	,,	,,	,,	20	,,	(1 pint) beer.

If a healthy man, then, take in 24 hours more than ⅘ths of a glass of whisky or brandy, 2 glasses port or sherry, 4 glasses (a half-pint) claret, or hock, or champagne, or a pint of beer, he takes a quantity which will produce effects on the bodily organs likely to be injurious, whether such effects are perceptible or not. For women the quantity is smaller, and any quantity to children in health is injurious.

The value of Alcohol to the Body.—Judged by the facts that have been briefly passed in review alcohol has no value for the *healthy* human body, *under ordinary circumstances. The taking of stimulants is, therefore, a question of individual taste and pleasure,* just as is the use of condiments, and as soon as the quantity taken for pleasure exceeds a certain small amount the region of possible danger is entered. Within the limit named, each person must be allowed to act according to his own judgment and inclination. There are, however, circumstances in which alcohol has, or is generally supposed to have, directly beneficial effects, circumstances which may be said to be more or less beyond the ordinary. What are these circumstances, and how far is the general idea concerning them correct is our next question?

It is a common idea that alcohol in some form is exceedingly useful when the body is subject to the pressure of great exertion. On this point there is now, fortunately, a great body of evidence, drawn chiefly from the experience of troops on the march and engaged in fighting. Dr. Parkes thus summarizes the results of his observations during the Ashanti campaign (1874). "The first effect of alcohol,

when given in a moderate dose (for example, what is equal to one fluid ounce of absolute alcohol), is reviving, but this effect is transient. The reviving effect goes off after at the utmost two and a half miles of additional march, and sometimes much before this; then the previous languor and sense of exhaustion not only return, but are sometimes more intense, and if alcohol is again resorted to, its effects are now less satisfactory. Its reviving power is usually not so marked; and its peculiar anaesthetic and narcotizing influence can usually be distinctly traced. The men feel heavy, dull, disinclined to march, and are less willing and cheerful." In the Red River expedition, led by Sir Garnet Wolseley, spirit rations were not issued. "The men were allowed a large daily ration of tea, 1 oz. per man—practically as much as they could drink; and, as I am now on this subject of bohea *versus* grog, I may as well state that the experiment was most successful. The men of no previous expedition have ever been called upon to perform harder or more continuous labour for over four months. . . . This expedition would have been a bright era in our military annals had it no other result than that of proving the fallacy hitherto believed in of the necessity of providing our men when in the field with intoxicating liquors." Sir Garnet Wolseley recommends substituting tea for rum, which results in increasing the efficiency and health of the men. There is abundant and remarkable evidence to the same effect. It appears, then, that alcohol by its stimulating effect may enable one to put forth a great effort for a very brief period. But it supplies no energy for overcoming the difficulty; it compels an increased expenditure of energy without supplying the material from which the energy is to be obtained. As a result in a brief period its effect is over, leaving greater exhaustion than before. It lessens the power of sustained work. Its action in this way may be compared to putting the "blower" on a low fire, which occasions a more rapid entrance of air and a temporary quickening of the dying flame. It is like the prick of the spur in the side of the tired horse, "eliciting force without supplying it." If alcohol is useful in fatigue, it is not when the work is being done, but *after it is over*, if restorative food can also be had. Then it may be like the "blower" over a low fire, *which has received a new supply of coal.* It stimulates the exhausted body to appropriate the benefits of the food, though even under these circumstances its use is inadvisable if food and rest are sufficient for the purpose.

Alcohol has been supposed to be useful during prolonged exposure to cold. The error here is easily pointed out. By its stimulating effect upon the heart, and the dilatation of the smaller blood-vessels it produces, it causes a freer supply of blood to the skin, and a consequent glowing sensation of warmth. This, however, is delusive. The spirit supplies no added heat worth noting, and the greater quantity of blood flowing in the skin exposes the body to a much increased loss of heat. We have seen (p. 309) that the heat of the body is maintained in a cold external atmosphere by contraction of the vessels of the skin, and a lessened supply of blood to the surface. Alcohol produces the opposite effect, and thus the body parts with its heat at a greatly increased rate. Its use under these circumstances is dangerous. But when the exposure to cold is over, and the person is amid comfortable surroundings, then, if necessary, alcohol may be used, and quickly arouses a feeling of warmth by permitting the blood to flow to the skin.

The opposite condition to cold, great heat is, it appears, also less easily borne with the use of alcohol, which, according to Parkes, predisposes to sunstroke.

The value of alcohol when food is persistently deficient has been already alluded to. In ordinary circumstances one would say the food ought to be as readily procurable as the alcohol, and at a much cheaper rate. In cases of disease, however, when the difficulty of taking food cannot be overcome, alcohol does often become an agent of great value. But if the use of alcohol were restricted to disease, few would be found to object. This circumstance connected with alcohol has, however, a bearing which may be indicated in closing these considerations.

Hitherto the author has not sought to express any opinion as to the value of alcohol. His desire has been simply to marshal the chief facts which scientific investigation has revealed, whatever these facts might be. The only opinion he ventures to offer, he indicates now, and because of its bearing upon the use of alcohol under circumstances of deficient food. It appears to him that the ignorance of a very large proportion of women of the working-classes, in particular, regarding the proper quality of food needful to sustain the body, their inability to prepare plain nourishing food in appetizing forms, their tendency to provide whatever gives least trouble, such as the almost

invariable tea bread and butter and bacon, which appeases the hunger without yielding sufficient for the repair of tissue and the liberation of energy for work, these form one of the main causes of the large amount of intemperance among the working-classes of the population. The men are not stimulated by their food, they are continually below par as regards energy for work, they know little of the buoyant elastic mood to which work is a delight, and consciously or unconsciously they feel a craving for something to stir them. So they take the spirits to raise the steam, and a vicious habit is speedily developed. "In many places," says Liebig, "destitution and misery have been ascribed to the increasing use of spirits. This is an error. The use of spirits is not the cause, but an effect of poverty. It is an exception from the rule when a well-fed man becomes a spirit-drinker. On the other hand, when the labourer earns by his work less than is required to provide the amount of food which is indispensable in order to restore fully his working power, an unyielding inexorable law of necessity compels him to have recourse to spirits. He must work, but in consequence of insufficient food, a certain portion of his working power is daily wanting. Spirits, by their action on the nerves, enable him to make up the deficient power at the expense of his body, to consume to-day that quantity which ought naturally to have been employed a day later. He draws, so to speak, a bill on his health, which must be always renewed, because, for want of means, he cannot take it up; he consumes his capital instead of his interest; and the result is the inevitable bankruptcy of his body."

One remedy for such a state of things is, not temperance or teetotal lectures, however valuable these may be, but disseminating broadcast among the people a knowledge of the uses and properties of foods, and their economic value, and teaching their daughters how to cook palatable and pleasant meals from plain and cheap materials, and how to serve them with decency if not with grace.

The value of alcohol in disease is undoubted. It would, however, serve no good purpose to consider it in this place. Its use has been now and again indicated in discussing special diseases in the first part of this work.

Wines from the Grape.

The Preparation of Wine.—Wine is the fermented juice of the grape. The fermentation takes place spontaneously and naturally speedily after the grapes have been crushed. The ferment is the same as has been noticed in speaking of the manufacture of alcohol, namely yeast, but it is not added as in producing alcohol or beer. It is already present on the exterior of the grape, and as soon as, by crushing, the juice and ferment meet one another, the process begins. The action is the same as that already described. The yeast acts upon the sugar, contained in the juice to the extent of 13 per cent, as shown in the table on p. 574, and converts it into alcohol and carbonic acid gas. Upon the extent to which the fermentation proceeds will sugar be left in more or less diminished quantity when it is completed. If very little sugar remains the result is a **dry wine**; but if a large quantity of sugar has been present in the grape juice, it will produce a larger proportion of alcohol. As soon, however, as a quantity of alcohol in a liquid has been produced above 16 per cent by volume, fermentation ceases, no further transformation of sugar will be produced, and the result will be a **sweet wine.** Now the more ripe the grape is the more rich is its juice in sugar. This ripening is produced by the influence of the sun's rays; and, therefore, it is in warm countries, such as Spain and Portugal, where the sweet strong wines, port and sherry, are prepared; and it is in more northerly regions, where the grapes can hardly be so fully matured, that the lighter and dry wines are produced—claret, hock, &c. Therefore, also, not only the climate influences the kind of wine which a particular district produces, but the quality of the wine produced in the same district, will vary with the season. Wine manufactured from grapes which have not arrived at the highest stage of maturity will be, on the same account, more acid than that prepared from fully ripe grapes. Some of the richest and most fruity wines, such as Tokay, are produced from grapes allowed to remain long on the vines, so that they develop a large amount of sugar and attain some degree of concentration of juice by the evaporation of water. In the Sauterne and other districts some of the richest wines are obtained by selecting the grapes, picking them from the bunches as they reach perfection.

In the process of manufacture the grapes are first crushed, formerly by being trodden by the feet, but now usually by mechanical means. When this has been done the juice, now termed **must**, may be drawn off and allowed

to ferment separately, or the whole mass is allowed to undergo fermentation together, the quality of the product varying with the process adopted. The fermentation sets in rapidly, and is completed in two or three days, or after a much longer time, according to the warmth of the place. During fermentation a froth collects on the surface owing to the rise of carbonic acid gas in bubbles. This is skimmed off several times. As the violence of the process diminishes the liquid begins to become clear by the settling of a sediment or "lees." This consists of exhausted ferment, precipitated organic matter and tartrate of potash, which the now alcoholic fluid cannot keep in solution to any great extent. The clear wine is now racked off and run into casks, where it slowly undergoes a further fermentation, and another quantity of sediment is thrown down. With the slow production of more alcohol, more tartrate of potash is precipitated in a crystalline form, called **argol**. In the course of this further fermentation, the wine is several times racked off and transferred to other casks. The material left in the fermenting vat, called **murc or mark**, is pressed, and the best of the liquid obtained may be placed in the casks, the muddier portion being used for inferior wine.

Now it is plain that during the process that has been indicated there is a multitude of circumstances, which will influence the character of the wine produced. If, after the grapes are crushed, the juice is expressed and fermented alone, a very different wine will be produced from that yielded by the fermentation of the juice with the skins, seeds, stalks, &c. When the juice alone undergoes fermentation a **white wine** is yielded, no matter though purple grapes have been used, for their juice is devoid of colour like the white ones. If, however, the skins are not removed, as soon as alcohol is produced it attacks the colouring matter in the skin, dissolves it out, and a **red wine** is the result. From the skins also, and seeds and stalks as well, an astringent material is derived and, thus, wine obtained from fermenting the juice along with skins, seeds, and stalks is more astringent. Again the quality varies with the rapidity of fermentation; for the slower this process, the more extensively do other changes occur besides the formation of alcohol and carbonic acid gas; these changes are the development of ethers, essential oils, &c., which give aroma and fulness to the flavour. On the other hand, if the process has been too rapid, time has not been given for these substances to form, produced as they are by slow oxidation changes, and the wine is thin and characterless. Sometimes alcohol is added to check the fermentation earlier than usual. Such wines, owing to the sugar not being nearly exhausted by the ferment, subsequently undergo slow changes which increase the bouquet and flavour of the wine, so that it matures with age. Wines which have had spirit added for such a purpose, or because they contained so small a percentage of alcohol as to be devoid of good keeping properties, are called **fortified wines**, while those which contain simply the alcohol due to fermentation are called **natural wines**. The wines of Portugal, Spain, Madeira, and the Cape are commonly fortified, those of France, Germany, and Hungary are more commonly natural wines.

Natural wines should not contain more than 7 to 13 per cent by volume of alcohol, while fortified wines contain 14 to 18.

The final process of wine manufacture is "fining." This is effected by the addition of isinglass or white of egg which carries down organic impurities and leaves the wine clear. It is allowed to remain at rest for several weeks after the addition of this agent, then it is racked off into another cask and is ready for bottling.

The Composition of Wine.—The composition of the grape has been shown on p. 574, and that of the juice before fermentation is, of course, similar. It contains water, sugar, albuminoid (nitrogenous) material, non-nitrogenous substances, other than sugar, such as gum, pectin, fat, &c., tartaric acid combined with potash, as tartrate of potash, fibre, and mineral matters, such as potash, soda, lime, magnesia, &c., in combination with sulphuric and phosphoric acid, and in the skins and stalks there are tannin and colouring matters. Now by fermentation the sugar becomes changed into alcohol and carbonic acid gas; the fermentation produces, besides, glycerin and succinic acid. Further, by the action of oxygen upon the alcohol produced, acetic acid is formed, and a substance called aldehyde which confers a peculiar smell and flavour. While, therefore, the acid of grape juice is mainly tartaric acid, the acids of wine are tartaric, acetic, succinic, carbonic, and formic, the last four resulting from the fermentation. There are also small quantities of fatty acids, and tannic acid when the skins and stalks have fermented with the juice, as in the case of red wines. Further, in the process of maturation of wine, ethers are formed by the action of

acids on the alcohol. They are formed slowly and in small quantity, being present, therefore, to greatest extent in old wines, and it is owing to their presence that old wines have the fruity aroma which makes them prized. An ether, produced by the action of a fatty acid on the alcohol, is œnanthic ether to which, though it is said to be present to the extent of only one part in 40,000, the characteristic smell of wine is mainly due. It is its presence in the spirit of wine—brandy—that gives to it its peculiar flavour and odour. By the action of the various acids upon the alcohol in new wine numerous ethers are produced, which process diminishes the alcoholic strength of the wine but develops its aroma. As already said it is only in old wines that these changes have occurred to any great extent. Much of the albuminous material of the juice of the grape disappears in the fermentation process, some remains and in time is precipitated by tannin, forming part of the crust of wine. Wine also contains less mineral materials than grape juice, because much of that material cannot be kept in solution when the liquid becomes alcoholic. It is in part precipitated as the fermentation goes on, and subsequently much mineral material is deposited in the crust, such as the bitartrate of potash (cream of tartar) and phosphate and tartrate of lime.

The changes which take place in wine, then, with age, are diminution or disappearance of sugar that may have escaped fermentation, diminution of alcohol and of acidity by the production of ethers and consequent improvement in aroma and flavour, and diminution of tannin albuminous and mineral matter by precipitation as crust; colouring matter is also deposited, so that the colour is also less dark.

There is a process, known as "plastering," employed during the production of wine which alters the quantity and kind of mineral substances present. It consists in dusting over the grape juice, before fermentation, sulphate of lime—plaster of Paris or burned gypsum. The object of this is to remove some of the acid flavour. Sherry and port are almost regularly subjected to such treatment, as well as certain wines of France and Greece. Tartrate of potash is removed by this means, tartrate of lime being formed and precipitated; but sulphate of potash is also formed; it is a bitter salt and remains in solution. The tartrate of potash thus removed from the wine is one of its most valuable salts. The process, according to Hassall, "deprives the wine, in fact, of a very valuable salt, substituting another salt of an injurious character." Wines are also frequently coloured artificially by the addition of burned sugar or vegetable colouring matters, and are also artificially flavoured by the use of elder flowers and other substances.

The following table from Church shows the constituents of the chief wines in ordinary use. The percentages of alcohol present in different varieties of wine is shown on p. 667.

Constituents of One Imperial Pint of Various Wines.

	Port.		Madeira.		Sherry.		Carlowitz.		Burgundy.		Champagne.		Claret.		Hock.	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Absolute Alcohol,	3	218	3	218	3	147	2	35	2	18	1	343	1	306	1	219
Sugar,	0	359	0	175	0	236	none			10	1	120	0	9	none	
Tartaric Acid,		23		26		24		36		24		20		31		39
Acetic Acid,		12		18		12		19		17		10		18		18
Ethers,		6		5		4		5		6		5		6		4
Mineral Matters,		20		33		38		16		18		20		18		16

Besides the variation in the quantity of alcohol, one notes in this table the greater proportion of sugar in port, Madeira, sherry, and Champagne, and its absence in Carlowitz, Burgundy, claret, and hock, while the acidity of the latter is greater.

It does not fall within the purpose of this work to describe the various detailed differences between the various wines, sherry, port, Champagne, their special mode of production and so on.

The Use of Wines.—The action of wine on the body is determined to some extent by the quantity of alcohol contained in it. But it is said that the presence of ethers, mineral materials, &c., considerably alters the nature of its action, so that it does not so readily tend to produce injurious changes on the body as whisky or brandy or other strongly-alcoholic liquors. It is to be noted, however, that the strong wines, such as port, are usually taken undiluted, while whisky is usually drunk largely diluted; and thus those who take the fortified wines take alcohol in a more concentrated form than if they took whisky and water. Apart from the alcohol, the presence of sugar in some wines gives them a value as food-stuffs, and the mineral matters also occasionally are useful

to the body. It must not be forgotten that wines, almost without exception, interfere with digestion, if consumed to any extent (see p. 604), and interfere to a greater extent than the same quantity of alcohol, taken as whisky and water, would. This action is most marked in the case of the rich sweet wines, and least in hock and kindred wines. If wines are to be used at all, in health, preference should be given to the lighter French, German, and Hungarian wines, the clarets, hocks, and such a wine as Carlowitz, while sherry, port, Marsala, Madeira, and such wines should be in general avoided, and most particularly by dyspeptics, gouty and bilious subjects. These richer wines are often exceedingly valuable in enfeebled conditions, but are not advisable for ordinary employment. The Australian wines now freely employed afford an excellent supply of light wine for those who insist upon some such beverage daily. They are natural wines, of soft and delicate flavour, and with an aroma of their own. Anyone who believes he needs some stimulant to his appetite cannot do better than use such a light one, particularly in face of the difficulty of obtaining a good claret. If one really needs and derives benefit from such a stimulant with food, let him try a glass of good claret or similar wine, made up to a tumblerful with boiling water, and sipped throughout the meal. Sparkling wines, and particularly of a dry kind, and specially a dry Champagne, are often exceedingly useful in disease, when the stomach rejects food and other kinds of stimulant. The sparkle, due to the escaping carbonic acid gas, is grateful and often soothing to the stomach, and the restorative action of such wines is more rapid than that of still wines or ordinary spirits.

The Adulteration of Wines.—It is useless to speak of the value of wines without noting the enormous difficulties in the way of obtaining what is genuine. It does appear that actually good wine is almost beyond the reach of any but those who are able to pay a good price. The fact that wine is valuable under certain circumstances is, therefore, qualified by the fact that it is only procurable by the few. This will be sufficiently shown by the following extracts from Dr. Hassall's book on *Food and its Adulterations*. "Scarcely a natural sherry is to be met with in this country. The very finest and purest sherries imported . . . are fortified with grape spirit only, or with grape spirit, grape sugar, and grape colouring; . . . but the great bulk, we fear, of the sherries consumed in Great Britain, contain foreign spirit, foreign sugar, and foreign colouring, and are, in fact, mixed and adulterated." "A kind of sherry is manufactured in this country, the basis of which is pale malt and sugar-candy, a small quantity of French brandy and inferior wine being added to flavour the mixture." "Port wine is subject to a large amount of adulteration before it reaches this country; after its arrival here it is frequently subjected to further sophistication. Sometimes it is diluted, brandied, and then coloured by the mixture termed Jerupiga, or by means of logwood. The brilliancy of the colour is sometimes increased by means of alum, and, if turbid, it is cleared by gypsum, while increased astringency is imparted by means of oak-sawdust. Not infrequently peculiar flavours or bouquets are artificially communicated to port wine; the principal substances used for this purpose are extract of sweetbriar, orris-root, and cherry-laurel water."

Wines from Fruit other than the Grape.

Wine might be produced from any kind of fruit containing grape-sugar. The fruit is crushed like the grape, and the juice allowed spontaneously to ferment.

Cider is wine produced from crushed apples. After the fruit has been crushed, the juice is expressed, and then allowed to ferment, no yeast being added. The character of the liquor produced depends upon the kind of apple, whether it has been kept till fully mature, whether the juice has been expressed immediately after crushing, upon the length of time fermentation has been allowed to go on, &c. It contains usually from 5·21 to 9·87 per cent of alcohol by volume. If allowed to ferment too long, acid is readily produced, resulting in a sour thin liquid. In Normandy many varieties of apple are grown for the manufacture of cider.

Perry is prepared by a process similar to cider from pears. It contains usually about 7·26 per cent of alcohol.

Gooseberry Wine, Mulberry Wine, &c. may be prepared in similar ways from their respective fruits.

Beer and other Malt Liquors.

Preparation and Composition of Beer.—Malt liquors are prepared from malted grain, usually barley, prepared by the method already described at the beginning of the paragraphs on alcohol. The malt is mashed as explained in

these paragraphs, and the process carried on in a similar way to that for the production of alcohol, till the wort has been produced. The wort is then boiled, and here the first difference arises, consisting in the addition to the wort of hops. These are the female flowers of a plant belonging to the natural order *Urticaceæ*, the *Humulus lupulus*. They are grown to greatest perfection in Kent and Sussex. They contain an oil, the oil of hops, a bitter principle called lupulin, which are the two chief ingredients from the brewer's point of view, a resin, tannin, and mineral matters, &c. It is for the flavour and bitter, as well as for their preservative qualities, that hops are employed; and they impart an aromatic and tonic character to the infusion. The hops are added to the wort in the copper, in quantity dependent upon the liquor to be produced, for ale about 8 pounds of hops being added to one quarter of malt and 180 gallons of water, this quantity yielding 108 gallons of ale, water being lost in the course of the various processes. After being boiled the liquor is drawn off, strained, cooled to a proper fermenting temperature, and the yeast added. In three or four days the process is completed. The fermentation is not carried so far as in the production of alcohol, since in the manufacture of beer it is desired to leave some sugar unconverted. After fermentation the liquor is allowed to clarify, "finings" of isinglass being sometimes added to facilitate that process. The beer is then racked off into casks for use.

The kind of malt liquor produced depends upon the kind and quantity of malt used, the quantity of hops added, the extent to which fermentation is carried, and on various other circumstances. The greater the quantity of malt used, the higher is likely to be the alcoholic strength of the beer. Pale malt is used as a basis of all malt liquors, dark malts being employed in addition to give the colour to stout, porter, &c. Ale is manufactured from the pale variety only.

Malt liquors contain water, alcohol, and sugar, dependent upon the extent of the process of fermentation, albuminous substances of the malt extract, carbonic, acetic, lactic and succinic acids produced by the fermentation, bitter and colouring matters, and saline substances. The kind of water with which beer is brewed is understood to affect its quality. Thus the special character of Burton-on-Trent brew is believed to be due to some extent to the water, which is rich in mineral constituents.

The following is an analysis of a stout:—

Alcohol (by weight), ...	... 5·51	per cent.
Soluble Albuminoids,	... ·69	,,
Sugar, Dextrin, &c., ...	... 6·74	,,
Acetic Acid, ...	... ·05	,,
Lactic Acid, ...	... ·18	,,
Mineral Matters, ...	... ·37	,,

The following table from Church indicates the constituents of stout and ale:—

Constituents of One Imperial Pint of Ales and Stout.

	London Stout.		London Porter.		Pale Ale.		Strong Ale.	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Water, ...	18	343	18	412	18	409	17	399
Alcohol, ...	1	74	1	10	1	12	2	18
Acetic Acid, ...		22		16		17		21
Extractives,[1]	1	25	1	3	0	372	2	42
Mineral Matter, .		22		18		10		30

Twenty ounces of beer (one pint) yield about one ounce of absolute alcohol.

Lager Bier (Munich) contains 5·1 per cent of alcohol, and 5 per cent of malt extract.

White Beer (Weiss Bier) contains 1·9 per cent of alcohol, and 5·7 of malt extract.

The Value of Malt Liquors.—Besides the alcohol, whose effects have been already discussed, malt liquors, as shown by the tables, contain undoubtedly nutritive materials in the shape of albuminoids, sugar, &c., derived from the malt extract. These materials are contained in largest amount in stout porter and strong ale. Such liquors thus possess stimulating, nutritive, and tonic properties, the latter being most marked in the pale ales. When taken in any quantity they tend to interfere with the due combustion of fats, and probably also carbo-hydrates in the body. In consequence a fat and bloated appearance is apt to be induced, more particularly as the liquor contains considerable quantities of fattening material in the shape of sugar. Moreover, the same interference with the natural action of the bodily organs leads to an accumulation within the system of imperfectly oxidized substances, resulting in impaired digestion, interference with the functions of the liver, gouty and bilious affections, nervous irritability and the like. According to the calculation already made (p. 672) the use of beer should be restricted to one pint per day. Stout and porter are frequently found valuable in the treatment of diseases of mal-nutrition, and they are in frequent use by nursing mothers. It would be well, however, if the employment of such agents in general weakness or disease were regulated by medical advice.

[1] This includes albuminoids, sugar, dextrin, &c., derived from the malt and hop extract.

SECTION III.—AIR, VENTILATION, AND WARMING.

Air.

The Necessity for Air.

The Atmosphere:

Physical Properties of Air—Effects of Temperature and Pressure—
Effects on the Body of Increased and Diminished Pressure—Mountain Sickness—Cupping Glasses.

The Composition of the Air—
Oxygen and Nitrogen—Difference in Quantity of Oxygen in a given Volume of Air according to Pressure and Temperature—Ozone.

Carbonic Acid of the Air;

Impurities in the Atmosphere—Dust in the Air—Germs in the Air—Observations with the Aeroscope;

Purification of the Air.

Ventilation.

Air of Confined Spaces:

Air Vitiated by Breathing—Smell as a Test of Impurity;

Quantity of Fresh Air required per head per hour.

Effects on Air of Burning of Candles, Gas, Fire, &c.;

Moisture in the Air.

Methods of Ventilation:

Ventilation by Diffusion of Air through Walls—Permeability of Walls—Construction of House Walls, Foundations, &c., in view of this;

Position of Openings for Ventilation;

Inlet Ventilators—Window Ventilation—Sheringham's Ventilator—Tobin's Tubes;

Outlet Ventilators—Ventilators in Chimney—Shaft Ventilators, Boyle's, Watson's, M'Kinnell's;

The Size of Ventilating Openings;

Ventilation by Chimney—Causes of Bad Draught.

Warming.

Conduction, Convection, and Radiation of Heat.

Heating by Open Fireplace and by Hot Air contrasted:

The Construction of the Ordinary Grate—Teale's Economizer;

The Galton Grate;

German Stoves and Gas Stoves.

AIR.

The Necessity for Air.—In the first part of this work, in Section IX. A, the process of respiration has been considered, and the means by which air from the external atmosphere is taken into the lungs have been explained in detail. The reason for the introduction of air has also been briefly set forth, namely that oxygen is necessary for the life of the tissues, and that the blood flowing in the fine blood-vessels of the lungs obtains oxygen from the air introduced, and carries it to the tissues (see pp. 249, 257, and 261). Moreover, the purpose served by the oxygen derived from the air is sufficiently indicated in the early portions of Section I. of Part II., where the energy of the body is shown to be derived from food-stuffs by a process of combustion, or oxidation, or union with oxygen (see pp. 527 and 531). The food-stuffs themselves contain oxygen as part of their chemical constitution, some to a great extent, like starch and sugar, others to a less extent, like fat; and thus they may undergo partial oxidation without any added quantity of oxygen being supplied. But none of them contains sufficient oxygen for complete combustion either outside or inside the body.

Thus sugar	contains	51	parts	of oxygen	in every	100
starch	,,	49	,,	,,	,,	100
fat	,,	10	,,	,,	,,	100

But these are totally insufficient quantities of oxygen to effect complete combustion of the food-stuffs, &c.

For 100 parts of	sugar	require	103	of oxygen for complete combustion.	
,, ,,	starch	,,	120	,,	,,
,, ,,	fat	,,	293	,,	,,

There exists, therefore, the necessity of introducing into the body a very large quantity of oxygen wherewith the food-stuffs may combine to yield energy for work and heat; and this large quantity is introduced from the atmosphere by the process of breathing. We have already commented (p. 619) on the fact that different climates require different foods, not only because more heat is necessary to maintain

the bodily temperature in one—a cold climate, and less in another—a hot climate, but also because sufficient oxygen cannot readily be introduced in the hot climate, where the atmosphere is rarefied, to oxidize such foods as fat; while it is easily introduced in the cold climate, where the atmosphere is condensed.

It is important then to consider the nature of the atmosphere, under varying circumstances, since it plays so important a part in the processes of life.

The Atmosphere is the gaseous envelope which surrounds the earth. At a distance from the earth, not positively determined, it ceases; the distance being usually set down at from 40 to 45 miles on an average. Now air has weight, though that is not immediately apparent. If a flask, in the condition in which it is usually called empty, but when it is really filled with air, be balanced on a scale-pan, and then by means of an air-pump if the air be withdrawn, and the flask be then replaced on the pan, it will be found lighter, the loss being the weight of air removed. It has been found that 100 cubic inches of air weigh 31 grains at a temperature of 32° Fahr. and when the barometer registers a pressure of 30 inches of mercury. At this same temperature and pressure a cubic foot of dry air weighs 566⅘ grains. Air can be compressed; its particles which tend to expand, to repel one another, can be pressed more closely together, in which case the bulk of air can be diminished. At the surface of the earth, then, at the level of the sea, the atmosphere exerts a certain pressure, the pressure or weight of the 45-mile layer of air between the limit of the atmosphere and the given place. The layer of air nearest the earth is bearing the weight of all the layers of air above it; and since air is compressible, the layer next the earth will be more compressed, will be more dense, that is to say, than any other layer higher in the atmosphere. So that as one ascends in the atmosphere the pressure and density will diminish. The **pressure of the atmosphere** at the sea-level is, as a mean, equal to the pressure of a column of mercury 29·92 English inches high. So that in a tube from which air has been withdrawn mercury will rise to that height by the atmospheric pressure. This is the height of the barometric column. The pressure of this column of mercury is equal to that of a column of water 32 feet high, water being about fourteen times lighter than mercury. This pressure is in round numbers equal to 15 pounds to the square inch. On everything at the earth's surface this pressure is exerted, on every part of our bodies also, on the outer portion of the body, and by the windpipe and bronchial tube on the inner surface of the lungs, &c. We feel no weight because the pressure is everywhere uniformly distributed. If one descends a mine the atmospheric pressure increases; as one ascends a mountain the pressure diminishes. If a very high ascent is made, whether by climbing a high mountain or ascending by a balloon, various effects are produced on the body, which taken together form what is called **mal des montagnes, or mountain sickness.** Among these symptoms are loss of appetite, thirst, sickness, vomiting sometimes of both bile and blood, frequent and difficult breathing, quickened irregular weak pulse, great muscular fatigue, headache, depression, and dimness of vision, congestion of the blood-vessels of the skin, and bleeding from the nose, eyes, ears, bowels, &c. These effects are partly experienced at a height of 10,000 feet, and almost certainly at an elevation of 17,000 feet, though they appear more quickly in some persons than in others. The causes of these symptoms are partly mechanical and partly chemical. The diminution of pressure outside the body, that within the blood-vessels and cavities of the body remaining the same, is sufficient to account for the rupture of blood-vessels; while the rarefied condition of the atmosphere, resulting inevitably in deficient oxygen being obtained, accounts for most of the others. Similar effects have been produced by submitting persons, in cylinders constructed for the purpose, to more or less rarefied atmospheres. On the other hand, when the body is submitted to an atmosphere whose pressure is greatly above the normal, as in a diving-bell, other effects are produced, diminution of rapidity of pulse and of breathing, increased appetite, &c., and ill effects follow a very high pressure. Whenever anyone has been subject to a very high pressure, as by working in a diving-bell or in caissons in deep water, return to the normal pressure should be effected gradually, not suddenly.

The effects of pressure on the body are illustrated by the action of cupping-glasses. These are small bell-jars, and they are applied in the following way. A penholder or similar piece of wood has a small piece of lint or cotton, &c., wrapped round one end, which is then dipped in spirit of wine, to make a small torch. The cupping-glass is placed upon the skin and raised on one side to permit of the penholder being passed inside the cup. The spirit is then lighted,

and the flame introduced for an instant into the cup and immediately withdrawn, when the cup is instantly pressed upon the skin all round. Vapour from the flame drives the air from the cup, and after the torch is withdrawn this vapour condenses. Air not being able to enter, a partial vacuum is created. Thus the pressure on the skin covered by the mouth of the cup is much less than that beyond it. In consequence the skin and flesh beneath it rise up into the cup, and the blood-vessels of the skin become congested with blood. The effect of this is to draw the blood from deep parts, and thus cupping-glasses used to be employed to withdraw blood from the seat of deep inflammation.

The **density of the air** varies also with the temperature. A high temperature causes the air to expand, and therefore to become lighter—that is, of two equal volumes of air at different temperatures that of the high temperature will weigh less than that of the low temperature. It is changes in the temperature due to local causes that occasion winds, the currents produced being the means for re-establishing equilibrium.

It is a remarkable circumstance that air has little power of absorbing heat, while it readily transmits it. Thus the heat-rays from the sun pass through the air without heating it to any great extent. When these rays fall upon the earth, it absorbs them and the earth's surface becomes warm. The layer of air in contact with the earth is then heated, because of its contact with the earth, and rises, cold air flowing in to replace it, to be warmed and in turn to rise, and thus a movement of air is created. The result of this is evident. If the air absorbed the heat-rays of the sun to any extent it would become unbearably warm and too rare for breathing purposes; while by the earth becoming warm and gradually giving out its heat, sudden changes are modified, and a degree of warmth kept up after sunset, coolness gradually, not suddenly, setting in.

The Composition of the Air.—The atmosphere consists chiefly of two gases, oxygen and nitrogen, not in a state of chemical union, but simply in a condition of mechanical mixture. It is somewhat singular that, in spite of varying conditions of place, climate, &c., the proportion of these two gases remains practically uniform, namely:—

20·9 per cent of oxygen, and } by volume.
79·1 ,, ,, nitrogen,

If the estimation is made according to weight, then 100 parts of air contain

23 parts of oxygen, and
77 ,, nitrogen.

Now it has been said that, at a temperature of 32° Fahr. and a pressure of 30 inches of mercury, a cubic foot of dry air weighs 566¾ grains. Taking the proportion of oxygen and nitrogen by weight as 23 and 77, then of this 566¾ grains, in round numbers,

436½ grains are nitrogen, and
130¼ ,, oxygen.

Total, 566¾

But it has been said that air expands with heating. A cubic foot of air at 32° Fahr. will be more than a cubic foot at 80° Fahr.; in other words, a cubic foot of air at 80° Fahr. will weigh less than a cubic foot at 32°. It weighs, indeed, only 516¼ grains, containing fully

397½ grains nitrogen.
118¾ ,, oxygen.

Then as to pressure, the cubic foot of air at a pressure of 30 inches contained

130¼ grains of oxygen;

but at a pressure of 25 inches of mercury, equal to an ascent in the air of about 5000 feet, the cubic foot of air is lighter and contains only

108·6 grains of oxygen.

Thus suppose a man breathing fifteen times a minute in a cold atmosphere, and obtaining thereby a certain quantity of oxygen. In a warm atmosphere, if he is to obtain the same quantity of oxygen, he must breathe faster. Similarly, if he breathes at a certain rate at the sea-level, and thereafter ascends a high mountain, his breathing must be quickened if he is to introduce the same quantity of oxygen into his blood.

Why does a man in good health usually feel buoyant, active, and able to do a considerable amount of hard work in cold weather? while in hot weather the same man feels dull, less disposed to activity, and certainly indisposed to hard work. The facts that have been stated supply part, at least, of the explanation. Hard work means increased liberation of energy in the body, increased oxidation changes, implying increased supplies of oxygen, obtained with comparative ease in the cold weather, when with every cubic foot of air breathed he introduces 130¼ grains of oxygen, but obtained with greater difficulty in hot weather, when he can introduce less and less oxygen with every cubic foot of air breathed, as the temperature rises, and thus cannot liberate energy in his body with the same rapidity.

In addition to oxygen and nitrogen air contains 4 parts of carbonic acid gas in 10,000, the quantity increasing slightly up to an elevation of 11,000 feet above the sea-level and then decreasing.

Watery vapour is also constantly present, varying in amount with the temperature of the locality, the higher the temperature the greater being the quantity of watery vapour which the air will hold. Thus at a temperature of 100° Fahr. each cubic foot of air will hold nearly 20 grains of water, while at freezing temperature each cubic foot will hold only 2 grains. As the air cools down from 100° Fahr. to freezing-point the watery vapour will, in consequence, separate out from it and be deposited. This is the explanation of the formation of dew. When the sun has set, the heated air rising from the earth deposits moisture as soon as it comes into contact with colder strata. When air at a certain temperature contains as much watery vapour as it can hold, it is said to be saturated for that temperature. If the temperature rise it can take up more vapour, and has got some drying power it had not at the lower temperature.

Besides the gases named and watery vapour there are present in air other substances, some of them gaseous and others solid; but these are rather to be considered impurities, and will be spoken of under that heading. It will be of much interest to note the value of these different constituents of the air.

Oxygen is a gas, colourless, and without taste or smell. It is the most abundant of all the elements in nature, and unites readily with almost every substance. When a substance unites with oxygen it is said to become **oxidized** and the process is called **oxidation**. This process may occur slowly or rapidly. When it occurs rapidly, the heat produced by the action is very apparent and the substance may burst into flame, and thus heat and light are produced. Thus when a fire burns, as already explained (p. 527), the carbon of the coal unites with the oxygen of the air. When a candle burns the substance of the candle unites with the oxygen of the air, the carbon of the substance uniting to form carbonic acid gas (CO_2, p. 651) with the oxygen, and the hydrogen of the substance uniting with oxygen to form water (H_2O, p. 636). When we burn coal-gas to give us light, the same thing happens. A very simple but very instructive experiment may easily be performed. Let a little wire stand be made so that two pieces of candle can be fixed upon it, one low down, the other near the top. Let this be set upon a large dinner-plate, let us say. Then let a bell-jar be taken, or such a glass shade as is used to cover a large pot of ferns or such like plants, of a size that the plate can hold. Light the pieces of candle, cover with the bell-jar, and pour a little water on the plate, to make a layer sufficient to cover the lip of the jar all round, so that no fresh air can enter. At first both pieces of candle will burn quite brightly. Soon drops of moisture will form on the inner surface of the glass jar, the moisture formed by the union of the hydrogen of the candle oil with the oxygen of the inclosed air. After some time the light will be perceptibly feebler, and the flames will become smaller, the lower one more slowly than the upper. By and by the upper flame will die out, the lower still burning feebly. If the bell-jar be lifted when the lower one is about to die out, it will immediately start again burning with vigour. The meaning of all this is that the oxygen of the inclosed air has gradually been consumed, and as the jar contained increasingly less and less the flames became feebler, because oxidation was less rapid. As the burning went on, not only watery vapour but carbonic acid gas was produced, which will not support combustion but will extinguish it. This gas, though heavier than air, rises to the upper part of the jar, because heated gas ascends and pollutes the atmosphere where the higher flame is burning, and as soon as sufficient has been produced it drowns it out, while the lower piece of candle still finds oxygen in the lower and colder part of the jar. When this lower piece is also about to go out from want of oxygen and from presence of carbonic acid gas, the raising of the jar supplies fresh air and it begins to burn again vigorously. As already explained this process of oxidation goes on in the living body, alike of animals and men, as part of the absolutely necessary processes of life. With a diminished supply of oxygen only feeble life could be maintained, just as only a feeble flame could burn. So that if a man or an animal were placed in a confined space, into which no fresh air could enter, his life would gradually become extinguished like the candle flame. The atmosphere, then, is the common source from which are drawn supplies of oxygen to maintain combustion for yielding heat and light, &c., and for the maintenance of life.

Furthermore the oxygen of the air is one of the most active of purifying agents. All organic matters exposed to the air undergo an oxidiz-

ing process, by which they are reduced to simple substances. Putrefaction and decay are processes of this kind carried on by the agency of minute living organisms. Thus all dead animal or vegetable matter undergoes oxidation and is reduced from useless and perhaps hurtful forms to valuable and harmless substances. So that the atmospheric oxygen is one of nature's great purifying agents.

One can obtain pure oxygen from substances which contain it in large quantity. Thus chlorate of potash, which is a chemical compound of chlorine oxygen and potassium, contains it in abundance. If chlorate of potash be heated in a flask oxygen is given off and can be led by a tube and collected in a jar over water. If a piece of wood with a bright glowing end be thurst into a jar of oxygen, it will immediately burst into flame and burn with great rapidity and brilliance. Such rapidity of combustion is not desired, neither is it possible for living beings to breathe anything like pure oxygen for any time with safety. While, therefore, it is the oxygen that is the valuable constituent of the atmosphere, it is necessary to be present in a diluted state.

The **nitrogen** of the atmosphere is a gas which performs the needful duty of diluting the oxygen. It also is a colourless gas without taste or smell. It does not burn and will not support combustion. A lighted candle thrust into a jar of nitrogen will immediately go out, not because the nitrogen extinguishes it, but because of the absence of oxygen to enable it to burn. It is an indifferent gas, with no active properties. In the atmosphere it acts, therefore, simply as a diluting agent for the oxygen. Its value, however, when in chemical combination, specially in the formation of organic substances like albumin (p. 536) has already been insisted on.

Ozone is a form in which oxygen exists, in which it has a peculiar smell and a very high degree of chemical activity. It is readily produced in air by passing electric sparks through it, and it is naturally produced in the atmosphere by the discharge of lightning. The activity of ozone in the work of oxidation and in the destruction of organic substances is much greater than that of simple oxygen, and an atmosphere rich in ozone is certain to be one of great purity. Perhaps this accounts for its absence from the air of towns, and its presence in the fresh air of the country.

Carbonic Acid Gas of the Air.—If, then, some one may say, with every act of combustion oxygen is consumed, and if life implies the removal of oxygen from the atmosphere, the quantity of oxygen daily removed from the atmosphere must be enormous. Moreover all this means not only the consumption of oxygen but also the production of carbonic acid gas, and this gas (which has been considered on p. 651) is inimical to life. In two ways the atmosphere is daily being vitiated to an enormous extent. This is all quite true. Thus De Chaumont makes the following calculation: "At the lowest estimate there cannot be less than 300,000,000,000 cubic feet of carbonic acid gas generated in London in a year from combustion and respiration, or a mean of 822,000,000 per day, or 34,250,000 per hour, or more than 9500 cubic feet per second. Now this is sufficient to double the normal amount of carbonic acid in 23,750,000 cubic feet of air per second, or in about 14 cubic miles every twenty-four hours, or more than 5000 cubic miles per annum. This represents a mass of air of the area of the metropolis, but extending upwards to ten times the height of the Himalayan Mountains." It has been estimated that in Paris one hundred millions of cubic feet of carbonic acid gas are daily produced, one-tenth by the respiration of animals and human beings, and the remainder by processes of ordinary combustion. How is it that under such circumstances all life does not speedily cease from the surface of the globe? The marvellous economy of nature is not unequal to the gigantic task of disposing of the enormous mass of carbonic acid daily produced upon the earth's surface. In the open air the carbonic acid gas is allowed to accumulate nowhere. By diffusion (see p. 258) the carbonic acid produced rapidly mixes with the atmosphere, while variations in temperature producing currents of air and so forth make the mixture still more rapid and thorough. Finally, while men and animals are constantly removing oxygen from the atmosphere and then returning it, combined with carbon, as carbonic acid gas, plants are as persistently reversing the process, *under the influence of sunlight* (see p. 258), removing the carbonic acid gas from the atmosphere, appropriating the carbon, to build it up into their structure, and returning the oxygen to the air. So that the purification of the atmosphere by vegetable life can always keep pace with its defilement by animal life, wherever the laws of nature are allowed their undisputed sway. As a consequence the remarkable fact has been shown that everywhere, *in the open air*, the proportion of carbonic acid

gas is pretty nearly the same, as the following list shows:—

Over the open sea the proportion is			·032	per cent.
At Portsmouth	,,	,,	·032	,,
,, Manchester	,,	,,	·037	,,
,, Aldershot	,,	,,	·040	,,
,, Tower of London	,,	,,	·042	,,
,, Chelsea	,,	,,	·047	,,
,, Munich	,,	,,	·050	,,
,, Arctic Regions	,,	,,	·055	,,
,, Top of Mont Blanc	,,	,,	·061	,,
,, Chamounix	,,	,,	·063	,,

Impurities in the Atmosphere.—Besides oxygen, nitrogen, carbonic acid gas, and watery vapour, there are many other substances found in the atmosphere, some gaseous and some solid, dependent upon locality, upon the nature of the earth's surface, upon the proximity to towns, manufactories, &c., upon animal and vegetable exhalations, and so on. The gaseous impurities are specially the product of manufactories, chemical works, &c., and are such as sulphurous and sulphuric acid, hydrochloric acid, ammonia, nitric acid. The two first of these result in quantity from the burning of coal, because of the sulphur it contains, and from the burning of gas made from common coal. The late Dr. William Wallace, city analyst for Glasgow, expressed the opinion that a million tons of sulphur contained in coal, are burned in Great Britain annually, producing fully three million tons of oil of vitriol. There is also a large quantity of vitiating gases passed into the atmosphere from manure and refuse heaps, from decaying organic matter, animal and vegetable, from sewage and so on. Salt is found present in air, derived from the ocean, even at considerable distances from the coast.

The nature and extent of the solid foreign impurities are more easily estimated. The fact that the atmosphere everywhere contains myriads of particles is matter of common observation. When a beam of sunshine passes into a darkened room through a chink in the shutter, the pathway of the beam is marked out by a white track through the darkness, a pathway formed of multitudes of dancing particles. But for the presence of these minute foreign substances, the pathway of the beam would be invisible. They catch the light and reflect it, and thus reveal the course of the light (see p. 388). If a lighted spirit-lamp be held under the beam, the white beam will at once appear as if cleft in twain by a dark gulf, as if it had been cut in two. The hot flame has destroyed the dancing particles immediately above it, and the light is passing across a space from which the particles have been removed, so that its pathway is no longer visible. Beyond the hot flame the track is white as before. This shows that the majority of these particles are organic in their nature since they will undergo combustion with such effects. How by various observers and by varied experiments it was finally established that the air-ocean which surrounds our earth was nearly everywhere teeming with life, like the liquid ocean of the sea, though of microscopic size, has been already detailed on p. 385 and subsequent pages. One of the most complete investigations into the character of atmospheric particles was conducted, less than fifty years ago, by a German, Ehrenberg, who investigated the exact nature of the elements of common dust found in houses, libraries, museums, towers, the Bernese Oberland, the High Alps, Lebanon, and the Himalayas. Later Dr. Douglas Cunningham, of the Indian army, made a most elaborate report to the Indian government on the foreign materials present in air, and numerous observers, German, French, and English, more particularly Dr. M. P. Miquel, of the observatory of Montsouris in the southern portion of Paris, have made careful and detailed observation on the particles present in atmospheric air at varying seasons and under a variety of circumstances.

The results of all these observations go to show the continual presence of particles, derived from the mineral, vegetable, and animal kingdoms, in the atmosphere. The wind carries into the atmosphere, even to great heights, sand, dried particles of mud, particles of coal, iron, &c., varying with the geology of the country and with the nature of the manufactures carried on in it. Dust raised by wind-storms may be carried over great distances. In Berlin atmospheric particles have been found, which had been carried from the deserts of Africa. The enormous numbers of these dust particles, invisible to the unaided eye, which may be present it is almost impossible to conceive. John Aitken, F.R.S.E., using a method of counting them, devised by himself, estimated that

In fair weather each cubic inch of external air contained	2,119,000
In rainy ,, ,, ,, ,, ,,	521,000
While in a room ,, ,, of air contained	30,318,000
And ,, ,, ,, ,, from near the ceiling contained	88,346,000

"It does seem strange," says Mr. Aitken, "that there may be as many dust particles in 1 cubic inch of the air of a room at night when the gas is burning as there are inhabitants in Great Britain, and that in 3 cubic inches of the gases from a bunsen flame there are as many particles as there are inhabitants in the world."

An apparatus employed for collecting particles present in the atmosphere is called the **aeroscope**, of which one form is shown in Fig. 268. The centre piece contains a disc perforated by holes round the side, and having in the middle a microscopic slide, fixed by clips. In front of this is fitted a funnel-shaped piece, the inner end of which comes to a fine point, and opens just in front of the centre of the glass slide. Behind is fitted a tail-piece which keeps the funnel always opposite the direction from which the wind is blowing. The aeroscope is fitted to the top of a post, fixed in the ground, so that it may revolve with the wind. A drop of glycerine is placed on the centre of the slide. The air blowing into the funnel is directed by the fine point on to the drop of glycerine, which thus catches many of its contained particles. The air then escapes through the holes in the disc. Dr. Cunningham used such an arrangement, and exposed different slides to the wind for a varying time, twenty-four hours or more, and then examined the slides with the aid of a microscope. Fig. 269 exhibits the contents of a part of one of his slides. By such means the air has been shown to contain, besides the mineral substances, mentioned above, grains of starch, the pollen grains of various plants, spores of cryptogamic plants, hairs of nettles and other plants, fragments of woody fibre, cotton, fragments of vegetable tissue, minute insects, diatoms, scales of insects, hairs of rabbits and bats, plumes of feathers, minute animals of the worm class, and so on. In towns fragments of shoe leather, particles of horse-dung, fibres from clothing, &c., have easily been recognized, picked up by the wind from the streets. All kinds of germs, which have been described in detail on p. 387 have also been found.

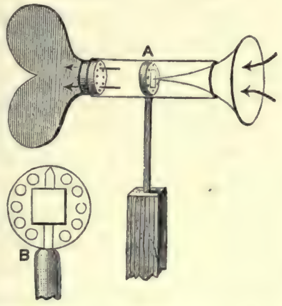


Fig. 268.—Aeroscope of Dr. Cunningham.

The use of the ordinary aeroscope, figured in Fig. 268, does not permit the number of atmospheric particles present in a given quantity of air to be counted. This more recent and more elaborate methods permit being done. Miquel in particular, has devised most ingenious methods of doing this, with the object of discovering how atmospheric germs were affected in number by rain, temperature, &c.

He found that the number was much diminished after rain. He also showed that if the air were not too dry, the number increased as the temperature of the air rose, but if the heat of the atmosphere passed a certain point, the number rapidly fell. After prolonged drought, moreover, the number diminished, moisture as well as heat being necessary for germ life. With the advent of cold weather, rapid diminution occurred. Thus from May to September the number of germs in the atmosphere about Montsouris Observatory was large, but with the advent of December the fall occurred and the number remained small till the advent of warmer weather in May. Montsouris is situated in the outskirts of Paris, so that the wind coming in one direction blows over the open country, while when it blows from another it passes

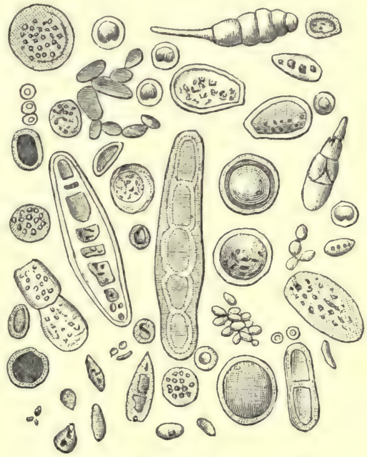


Fig. 269.—Atmospheric Organisms.

over the city. Miquel found that the wind which passed over Paris before reaching the observatory was always more laden with germs, picked up from the city, than that blowing direct from the country. He also always found the air more vitiated in the centre of the city than in his suburb. Moreover Miquel tried to find whether there was any discoverable relation between the amount of infectious disease in Paris and the number of germs in the atmos-

phere. He obtained the weekly returns of deaths from infectious disease in the city, and compared them with his tables of atmospheric life. At first he found no very striking similarity. But he bethought himself that it was unlikely that there would be any relation between infectious disease and the number of germs in the atmosphere about his observatory in the suburbs. So he transported his apparatus to a house in the centre of the town and proceeded to make observations. Then he obtained a very remarkable set of coincidences, for he found that whenever the weekly returns showed an increase in infectious disease his observations showed a rise in the number of air germs, and when the number of cases of disease fell, so also did the estimated number of organisms in the air. On several occasions the resemblances were very well marked, a great and rapid rise in the amount of infectious disease having an exact counterpart in a sudden great increase in the number of atmospheric organisms.

The Purification of Air of confined spaces is effected best by proper ventilation by methods already described. A large number of substances, solid, liquid, and gaseous, have also been used to effect the same purpose by chemical means. Thus dry charcoal, preferably animal charcoal, placed in saucers or other shallow vessels in the apartment, absorbs vapours and oxidizes animal emanations contained in them with great rapidity. It is said to be specially useful for air polluted with sewage gases. Solutions of Condy's red fluid, permanganate of potassium, are used in the same way. Carbolic acid in solution may also be used, placed in saucers, or sprinkled about the apartment. Chlorine gas destroys organic substances, and may be slowly disengaged in a room from chloride of lime moistened with water and placed in a shallow dish. If it be moistened with dilute sulphuric acid (oil of vitriol) the gas is disengaged rapidly. The fumes, however, are very irritating, and cannot be employed to any extent in an occupied room as the other substances can be. Iodine has also been used, being diffused through an apartment by allowing it to fall drop by drop on a hot plate and by other means. Sulphurous acid is employed for the same purpose by burning ordinary sulphur, but it also cannot be employed in an occupied room. Charcoal, Condy's fluid, and chlorine actually destroy by oxidation organic matters in contact with them, but the weak solutions of carbolic acid do not. The carbolic acid will arrest the growth of organisms, but preserves rather than destroys them. Some of these substances may be employed in the filter or troughs of inlet ventilators, and the ingoing air may thus be purified. The purification of rooms after infectious disease is described on p. 396.

VENTILATION.

Air of Confined Spaces.—Air, it has been already noted, undergoes constant defilement from the respiration of men and animals, from the burning of various substances, and by emanations from decaying animal and vegetable refuse. When natural laws are allowed full play, this vitiation is rapidly counterbalanced. The air rapidly mixes, animal and vegetable substances are speedily oxidized by the action of the oxygen of the air and by sunlight, and a normal standard of purity is easily and constantly maintained. If, however, the operation of natural laws is hindered or set aside, as by air being inclosed within confined spaces, so that free communication with the external atmosphere is prevented, then the impurity of the air is liable to become speedily marked. Wherever air is thus confined, and is at the same time liable to impurity by respiration, &c., it becomes necessary to provide special means of communication with the outside air, for the removal of the vitiated air and its replacement by a fresh supply. To such means the term ventilation is applied. To understand the full meaning of the word, it is necessary to have a correct appreciation of the nature and extent of the alterations thus produced on the air of inclosed spaces, and the effects of the alterations upon the healthy body.

Air Vitiated by Breathing.—Suppose a completely inclosed space inhabited by one or more persons, what changes does the air undergo? Oxygen is removed from it, carbonic acid gas is added to it, the amount of watery vapour is increased, and, besides, the air has added to it certain animal products, difficult to define, given out from the lungs and given off in the perspiration, &c., from the surface of the body. It is to these organic matters that the stuffy odour of an atmosphere is due, which has been rendered impure by the respiration of men or animals. The extent to which these various changes are injurious was shown long ago by an experiment performed by an Italian, Polli. He placed animals in inclosed spaces, containing the same quantity of air, but one of the spaces had an arrangement by which, by means of lime, the carbonic acid gas and moisture pro-

duced by the breathing of the animal were absorbed, another was provided with charcoal which absorbed and destroyed the organic exhalations, while a third had no arrangement for removing any impurity at all. Thus the air in the first space would be gradually deprived of its oxygen, and would have organic impurity added to it, the air in the second would have its oxygen diminished and its carbonic acid gas and watery vapour increased, but would have organic matter destroyed, while the air of the third would become impure by the abstraction of oxygen, and the addition of carbonic acid gas, watery vapour, and animal exhalations. The animal living in the last-named atmosphere died first, that living in the air from which carbonic acid gas was removed died next, and that in the atmosphere from which the organic matter was separated out by the charcoal lived longest. The organic products of respiration, &c., are then not only those which give the stuffy fœtid odour to ill-ventilated rooms, halls, &c., but also those which are most injurious to health. The unaided nose, therefore, is well fitted to warn of danger.

An atmosphere might contain abundance of oxygen, but if the carbonic acid gas were greatly in excess, it would still be an atmosphere fatal to life, for the excess of carbonic acid gas in the atmosphere would prevent the same gas produced in the body from being given off, indeed the gas would pass inwards to the blood from the external atmosphere. In such a case death would result from poisoning by carbonic acid gas, the symptoms being those of a narcotic poison, no struggling, no gasping for breath, but unconsciousness deepening into coma. On the other hand an atmosphere might be cleared of excess of carbonic acid gas without new supplies of oxygen being furnished to it. If deficiency of oxygen became very marked death would again result, but not from narcotic poisoning by carbonic acid gas, but from want of oxygen. It is in this circumstance that the hurried laboured breathing, and violent convulsive spasms of suffocation occur.

The facts then of special practical importance are that an atmosphere containing a proportion of carbonic acid gas produced by respiration, and charged, therefore, with organic impurity, will become inimical to life, even when it still contains a good proportion of oxygen. Thus the candle, which goes out in the bell-jar, is extinguished not for want of oxygen, for the atmosphere in which it goes out contains still from 15 to 18 per cent of oxygen, but because of the presence of the carbonic acid. If any arrangements existed for withdrawing this latter gas, the candle would continue to burn for a longer period.

The practical question comes to be what amount of impurity due to respiration may exist in the atmosphere of confined spaces without injurious effects on health, at what degree of impurity does an atmosphere become hurtful? As soon as that question has been answered, one proceeds to inquire by what methods one may prevent the air of inclosed spaces reaching this degree of impurity.

A considerable number of experiments have been made to determine the first question. Thus Dr. Angus Smith had a leaden chamber made, air-tight, in which he could sit for varying times, and from which samples of air could be drawn off for analysis. Professor de Chaumont found, as the results of experiments made by him, that the sense of smell gave pretty accurate indications as to the degree of purity of the atmosphere. These results are expressed in the following table:—

Ordinary atmospheric air contains ·04 per cent CO_2.

When the air contains *an added*	·0183	per cent	it gives no perceptible smell.
,, ,, ,,	·03894	,,	it smells rather close.
,, ,, ,,	·06322	,,	,, close.
,, ,, ,,	·08533	,,	,, extremely close.

If we add these quantities of carbonic acid gas produced by breathing to the quantity, ·04 per cent, already in the atmosphere, we find that when air contains ·06 per cent of CO_2 it is on the brink of becoming undesirable for breathing purposes; in round numbers when ·02 part CO_2 has been added to every 100 of the atmosphere by breathing, the limit has been reached for air that is to be considered pure. Now ·02 per cent is equal to ·2 per 1000 or 2 per 10,000. So if we express the above table in parts per 10,000, we shall have the following:—

Ordinary air contains 4 parts CO_2 in 10,000.

Air containing	6	,,	,,	does not perceptibly smell.
,, ,,	8	,,	,,	smells rather close.
,, ,,	$10\frac{1}{2}$	,,	,,	,, close.
,, ,,	$12\frac{1}{2}$	,,	,,	,, extremely close.

It must be remembered, however, that this only applies to air to which the added quantity of carbonic acid gas has been supplied by breathing. For the smell is not due to the carbonic acid gas; it is caused by the organic impurity also present in expired air. So that the quantity of organic impurity, which is detected by smell, is simply used as a rough index of the amount of CO_2 also present, both having been produced by the same process of respiration.

When the sensation of smell is taken as a gauge of the impurity, it must not be forgotten that one's sensation of smell is reliable for this purpose, only when one passes from fresh air into the confined space. Everyone is aware how very soon one gets accustomed to an atmosphere which seemed almost unbearable the moment one stepped into it. We often remain in a room or other confined space without being aware of the impurity which the atmosphere has attained. If we pass out from the room into the fresh air we are impressed with the pleasant freshness of the external air and involuntarily draw in deep drafts of it. If after a minute or two we pass back to the room, &c., which, in the meantime, we may suppose has been kept without any ventilation, we are at once conscious of the foulness of the air, we have been so long breathing without any consciousness of its impurity. Now it is not merely that we become accustomed to the atmosphere so far as our sensations are concerned, but the whole body adapts itself to the impure atmosphere. This has been easily proved in the case of the lower animals. Claude Bernard, the French physiologist, placed a sparrow in a bell-jar, which was inverted over mercury, so that no fresh air could enter. He found that it expired after three hours, before that time gradually becoming feebler and more languid till death occurred. If taken out at the end of the third hour it speedily recovered. But if an active sparrow were suddenly introduced, at the *end of the second hour*, into the jar, it died at once. That is to say the first sparrow could live a full hour longer in an atmosphere, to which it had become accustomed, and which was fatal to another sparrow suddenly introduced to it. The body can accommodate itself, if it has the opportunity, to a vitiated atmosphere to a certain extent; but this accommodation can be effected only by a depression of the bodily energies, by a lowering of the general vitality, which manifests itself in the languor, headache, listlessness, and lack of vigour so common to those who are accustomed to vitiated atmosphere for prolonged periods. A person of ordinary acuteness of smell may then judge accurately enough of the condition of the air of a confined space, provided he steps into it from fresh air, but the one who has been sitting in the vitiated atmosphere is least likely to be aware of its hurtful condition.

An atmosphere, then, to be considered of a healthy character, should not have more than ·2 part per 1000 of carbonic acid gas *produced by respiration*, or, as the phrase is, of respiratory impurity.

Quantity of fresh air required per head per hour.—Suppose one man to occupy a room 15 feet long, 10 feet broad, and 12 feet high. When empty this room would hold 1800 cubic feet of air. We shall suppose that with carpets, hangings, furniture and the man himself so much space was occupied that the quantity of air was only 1500 cubic feet. Suppose no air were to be able to enter or leave the room, we can easily calculate in what time the atmosphere would be polluted, by the breathing of the one man, to the limit we have named, 0·2 of a cubic foot of respiratory impurity to every 1000 cubic feet of air, that is 0·3 of a cubic foot to the 1500 cubic feet in the room. According to observations made by Pettenkofer, of Munich, an adult man produces in one hour 0·7 of a cubic foot of carbonic acid, when at rest; women produce less and children less also in proportion. Dr. Parkes and De Chaumont take 0·6 of a cubic foot as the fair average production by men, women, and children per head per hour. So that in half an hour, taking this average, the apartment named would contain 0·2 of respiratory impurity per 1000. At the end of an hour 0·6 of a cubic foot of respiratory impurity would be present in the 1500 cubic feet of air, that is 0·4 per 1000. It is clear that if this atmosphere is to be reduced to the limit of 0·2 per 1000, it would require to be diluted by an equal bulk of fresh air, it would require to be mixed with 1500 cubic feet of fresh air, and even then it would be on the verge of an improper degree of impurity.

To put it in another way, at the beginning of the hour the man enters the chamber containing 1500 cubic feet of fresh air, suppose that there is a current of fresh air passing through the room just sufficient to renew the whole air of the room once in the hour, that is to say, during the hour, 1500 cubic feet of air pass through the room. Then at the close of the hour the atmosphere will contain 0·2 of respiratory impurity per 1000. Suppose the man remains in

the room; he starts the second hour with 0·2 per 1000 of respiratory impurity already present, that is 0·3 of a cubic foot in his 1500 cubic feet of air; he produces during the hour 0·6 of a cubic foot of respiratory impurity, which, added to what was present at the beginning of the hour, makes 0·9 of a cubic foot of respiratory impurity. To reduce this 0·9 to 0·2 per 1000, 4500 cubic feet of air would be needed. But the apartment contains only 1500 cubic feet. So that if the atmosphere of the chamber is to be kept down to the proper limit, it will be necessary that during the second hour 3000 cubic feet of fresh air enter it. If a current of fresh air equal to this amount has passed through the room during the second hour, then at the end of it the respiratory impurity will be still at the limit of 0·2 per 1000. Suppose the man remains another hour, the conditions are the same as during the second, so that after the first hour he needs a supply of fresh air equal to 3000 cubic feet per hour. Whatever the size of the room one takes to begin with, it will be found on calculation, supposing the average production of carbonic acid gas to be 0·6 of a cubic foot per head per hour, and the respiratory impurity to be limited to 0·2 per 1000, that 3000 cubic feet of fresh air are required per head per hour. This calculation, it is to be observed, is made for persons at rest. De Chaumont says: "Of course in rooms occupied by persons in active work, more would be required, as from 50 to 100 per cent more impurity would be evolved; therefore, in ordinary workrooms, from 4000 to 5000 cubic feet per head per hour would be necessary, and in unhealthy trades 6000 to 7000. Some of my experiments were made in hospitals, occupied for the most part by ordinary cases, and I was thus enabled to compare the results with those in barracks occupied by healthy men. . . . It took nearly *one-third* more air to keep the atmosphere sweet in hospitals, so that we may safely lay it down that in ordinary cases no hospital ward ought to have less than 4000 cubic feet per head per hour, and that in cases . . . of epidemic disease the amount ought to be greatly increased; indeed practically the amount ought to be unlimited, so that many kinds of disease might be advantageously treated in the open air. This is proved by the great success of tent hospitals, both in time of war and in time of peace. In Germany this open-air plan has been practically tried to a great extent, and with very gratifying success."

De Chaumont gives a table, which I give here, to show the length of time it would take to bring the air in unventilated spaces of different sizes to the limit of purity (0·2 of a cubic foot of respiratory impurity per 1000 cubic feet of air):—

No. of Persons.	Size of Space in cubic feet.	Time taken to bring Air to Limit of Purity. hours.	minutes.	
One man	10,000	3	20	
,, ,,	5,000	1	40	
,, ,,	1,000		20	
,, ,,	600		12	
,, ,,	200		4	
,, ,,	50		1	
,, ,,	30			36 seconds.

The following table, showing the quantity of impurity per 1000 cubic feet of air produced by one man in inclosed spaces of different sizes, and the quantity of fresh air needed per hour to dilute the impurity to the standard limit, is derived from Parkes:—

Quantity of Air Space in cubic feet.	Quantity of CO_2, produced by Breathing, per 1000 cubic feet of Air per hour.	Amount of Fresh Air needed during the First Hour to dilute CO_2 to 0·2 per 1000.	Amount of Fresh Air needed to dilute CO_2 for every Hour after the first.
100	6·00	2900	3000
200	3·00	2800	3000
300	2·00	2700	3000
400	1·50	2600	3000
500	1·20	2500	3000
600	1·00	2400	3000
700	0·85	2300	3000
800	0·75	2200	3000
900	0·66	2100	3000
1000	0·60	2000	3000

Effects on air of the burning of candles, gas, &c.—The calculations that have been made have permitted no allowance for the burning of fires, candles, oil-lamps, or gas; and as these cannot burn without their due supply of oxygen, a considerable increase in the amount of fresh air will be necessary. Thus it has been calculated that one sperm or paraffin candle will produce in one hour half the quantity of carbonic acid gas produced by a man at the same time, so that two candles will necessitate an hourly supply equal to that for one man. A good oil-lamp produces rather more than ½ cubic foot of carbonic acid gas per hour—that is about the amount produced by one man, and a good gas-burner (which burns 3 cubic feet of gas per hour) will produce 6 cubic feet of carbonic acid gas per hour. Therefore one man and one good oil-lamp will together produce in one hour nearly 1·2 cubic feet of carbonic acid gas. To bring this down to the proper limit 6000 cubic feet of fresh air would be required per hour, no matter

what were the size of the space. Calculating on the same basis, one man and one gas-burner would produce 6·6 cubic feet of carbonic acid gas per hour, necessitating 33,000 cubic feet of fresh air per hour. This is an enormous quantity; and it must be remembered that the burning gas, while it yields much more carbonic acid gas than a man breathing, does not yield organic impurity, so that the necessity of diluting it to the same extent as respired air is not nearly so urgent. It has been thought that 1800 cubic feet of air per hour would be necessary for each cubic foot of gas burned. If 3 cubic feet per hour are burned, that implies 5400 cubic feet of fresh air for that purpose alone, which, added to the 3000 necessary for the man, amounts to 8400 cubic feet per hour for one man with one gas flame burning.

One pound of oil requires about the same amount of fresh air as 10 feet of gas. If the same amount of light is yielded by each, gas, oil-lamps, and candles render the air impure nearly to the same extent, so that there is not much to choose between them. As a matter of fact it appears that gas gives more illuminating power with a smaller consumption of atmospheric air than wax candles. But when lamps or candles are used, they are usually so placed as to throw the light in a particular direction, where the illumination is desired. The necessary illumination is obtained at a much less consumption of material, and the air suffers much less in consequence, not only because of a diminished production of carbonic acid gas but also because of a lessened amount of heat and moisture.

Another point, which requires consideration in the question of the quantity of fresh air to be supplied per hour, is the burning of fires. A fire in an ordinary fireplace, in a room 20 feet long by 20 broad by 12 high, is assumed to burn 8 lbs. of coal per hour. For proper combustion this coal requires 1280 cubic feet of air. It is to be noted, however, that the draught up the chimney created by the burning coal causes a current of air to the fire much greater than is necessary for the consumption of the coal. Probably twice the quantity of air, needed for combustion, is carried up the chimney; and 14,000 to 20,000 cubic feet of air is considered a moderate computation of the amount that will pass up the chimney of such a fire in one hour. In the burning fire, therefore, there is a powerful agent in the renewal of the air in an apartment.

Moisture of the Air.—Another factor enters into the calculation of the quantity of fresh air needed per hour in inclosed spaces, and that is the quantity of moisture the air contains. Watery vapour, it has been stated, is contained in fresh air in proportion to the warmth of the air. Air as it is breathed out from the body is saturated with watery vapour, and we know that if the air be breathed on a sheet of cold glass, the vapour will be deposited in the form of minute drops of water. Moreover watery vapour is constantly being given off from the body in the form of perspiration, usually invisible perspiration. The importance of this in regulating the temperature of the body has been referred to on p. 309. If the air surrounding a person be dry, that air can absorb moisture to a large extent, to a greater extent in proportion to the warmth of the air. If, on the other hand, the air is already saturated with moisture it cannot absorb more, evaporation cannot take place from the body, and the moisture will be readly deposited on the body itself. If the external atmosphere is cold this deposit of moisture will have the effect of rapidly cooling the body, because water is a better conductor of heat than air, and the thin film of water on the body will cause the body rapidly to part with its heat to the cold atmosphere, resulting in chilling. If the external atmosphere is warm and saturated with moisture, the body cannot part with its heat properly, and a feeling of oppressive sultriness and languor is produced. Now in a confined space, owing to the watery vapour given off from the lungs and from the skin, the air will by and by become saturated with watery vapour, and discomfort will be occasioned. This will happen sooner or later according to the size of the space. Therefore to prevent saturation occurring a fresh supply of air is needed. The burning of lights produces also watery vapour, and if any liquids be in the inclosed space, vapour will pass off from them, saturating the air more rapidly than if only the evaporation from the body of a person were occurring.

The degree of moisture in the atmosphere which is most comfortable to the body has been determined to be 75 per cent, complete saturation being assumed to be 100. The actual quantity of vapour in the atmosphere, sufficient to produce this degree of moisture will, of course, vary with the heat of the atmosphere. Thus at a temperature of 63° Fahr., 4·7 grains of water per cubic foot of air produce this degree, and at a temperature of 65° Fahr., 5 grains. That is to say the higher the temperature of the air the more moisture it can hold,

without exceeding the degree (75 per cent) most agreeable to health.

Now it has been calculated that an adult man will raise the degree of moisture in a space, containing 500 cubic feet of air at 60° Fahr., from 70 per cent to saturation in one hour, and with a space of 1000 cubic feet, occupied by one person, 3000 cubic feet of fresh air per hour would be necessary to maintain the degree of moisture at the proper level.

In short we have found that, if the air of an inclosed space is to be kept at a proper standard of purity, as regards the quantity of carbonic acid gas produced by respiration, 3000 *cubic feet of fresh air per hour, for every individual present, ought to be supplied, and that this same quantity of fresh air will keep the air of the apartment at a proper degree of moisture; and further we have found that, for every cubic foot of gas burned, an added* 1800 *cubic feet of air are necessary, while a fire needs a large additional quantity.*

The question, therefore, is now how can this large quantity of air be duly supplied without perceptible currents being produced, that is to say, without draughts?

For what does 3000 cubic feet of air per hour imply? It means that suppose a room affording only 500 cubic feet of air space, the whole air of the room must be renewed six times each hour, and if two persons occupy the room, the air requires renewal twelve times per hour. This could not be borne. If the room had 1000 cubic feet of air space, then the air needs renewal only three times per hour for one person, but six times for two. On the other hand a room having 3000 cubic feet of air space (and a room $15 \times 18 \times 13$ would have that, even allowing 500 cubic feet of space for furniture) would require renewal only once during the hour for one person, twice for two, thrice for three and so on. Renewal four times during the hour is the most that can be borne in a climate such as ours, where it is scarcely possible at any season to have the house freely open to the external air. It is, therefore, readily seen that the problem of ventilation is a very difficult one when one is dealing with small inclosed spaces, and also very intricate when one is dealing with halls, lecture-rooms, school class-rooms, &c. For in the small space the air must be renewed often, yet without draughts, and in the halls, &c., one expects large numbers of persons, and must again provide for frequent renewal of air. The problem, on the other hand, is simplified when one is dealing with, for example, a modern house, of large rooms with lofty ceilings, spacious hall, and so forth, in ordinary circumstances perhaps occupied by only six or eight persons at a time. But if on the occasion, let us say, of an evening party, the rooms are crowded with guests and many lights are burning, the difficulty of fresh air at once arises. It remains then to be seen how, in ordinary circumstances, these difficulties are met.

It is not, it must be observed, that a person living in a large space needs less fresh air than a person living in a small space, they both need the same, namely 3000 cubic feet per hour, but it is that this 3000 cubic feet of air can be so introduced and distributed in the large space that its entrance is not observed, while in the small space it is very difficult without elaborate arrangements to introduce the needful quantity without the establishment of unpleasant currents. High ceilings are, therefore, desirable, for it has been found that, if the height is less than 10 feet, currents of the circulating air are certain to be perceptible to a disagreeable extent. As regards floor space, it is desirable that the minimum should not fall below 50 to 60 square feet, per person, if possible not below 80 square feet. Taking 60 square feet and allowing the height of the room to be a minimum of 10 feet, that would allow 600 cubic feet of air space for each individual. This is the space allowed in barracks for each soldier, but 200 only is allowed in a cell of Chatham Convict Prison. If we take 600 as a standard, a room 10×12 and 10 feet high would contain 1200 cubic feet of air, and this should not contain more than two persons. One can, therefore, easily calculate the number of persons, inhabiting one room, that will be consistent with a fair standard of purity of air, by simply multiplying the length of the room by the breadth and the result by the height and dividing by 600. It will be noticed that to provide 3000 cubic feet of air per hour for one person in such a space, implies renewing the air of such a space five times per hour, implying careful arrangements for proper ventilation.

Methods of Ventilation.

Methods of ventilation are divided into natural and artificial. The artificial include those means adopted in large establishments, halls or churches, by which by means of some pumping or suction apparatus air is driven or drawn through the building. The natural methods are those which depend upon the ordinary

physical laws, which everywhere regulate the movements of air and wind. It is not the object of this work to consider the artificial methods, always requiring elaborate machinery, but to point out the principles that should guide the arrangements for securing natural ventilation, and the main simple contrivances employed for that purpose.

Ventilation through Walls.—A quite unsuspected means of natural ventilation has been pointed out by Pettenkofer of Munich, who showed and proved by an interesting experiment that air readily passed through the walls of a house, so that an exchange of air was effected between the atmosphere within and that without the house. This is effected by the physical process called diffusion of gases, already referred to on p. 258. Two gases will mix if placed in contact with one another, and they will also mix though divided from one another by a membranous partition, and they will mix with great facility through a partition of baked clay or other porous substance. It is in accordance with the same physical law that when there is the atmosphere of a confined space, the air of a room, separated by a wall—a porous partition—from the outside atmosphere, exchange and mixture should be effected through the wall. Such exchange will take place much more rapidly if the two atmospheres are at different temperatures, as they almost invariably are, the air of the room being warmer than that of the outside. Thus Pettenkofer found in the case of a room with brick walls, in which every crevice and crack had been carefully closed, and which contained about 2700 cubic feet of air, that the whole air of the room was completely renewed once in an hour by diffusion through the walls, when there existed a difference of temperature equal to 34·2° between the inside and outside air. When the difference of temperature fell to only 7° Fahr. the change of air fell to 780 cubic feet per hour, and with the same difference the change was increased to only 1060 cubic feet when a window 8 feet square was opened. This exchange through walls was illustrated by Pettenkofer in a very striking way by the blowing out of a candle through a 9-inch brick wall. If a brick be covered all over except at the two ends with a coating of wax, or other impervious material, and if then at each end there be fixed a small funnel, the junction of the two being also covered with wax, and if a lighted candle be placed near the opening of one funnel, and the person blow into the other funnel at the end of the brick, the candle flame will readily be made to flicker, and after a little with an effort may be blown out. By surrounding a piece of wall with an air-tight box and otherwise making an arrangement similar to that described with one brick, though on a large scale, the candle may still be blown out. It has been found by two German observers that with a difference of temperature of 4° Fahr. air passed, by this natural process of diffusion, through one square yard of wall, at different rates according to the nature of the material of which the wall was built, as the following table shows:—

1 Square Yard of Wall built of	Cubic Feet of Air per Hour passing.
Sandstone	4·7
Quarried limestone	6·5
Brick	7·9
Tufaceous limestone	10·1
Mud	15·4

It is clear then that the ventilation of a house will to a considerable extent be affected by the material of which it is built. A brick-and-mortar building is very pervious to air, so also is sandstone. Cement walls on the other hand are much less porous, and it is questionable whether they make a healthy house. If they are impervious to water from without, they are equally impervious to water from within. The watery vapour, given off by breathing which would be to some extent absorbed by the porous wall, is not absorbed by the impervious one, but the moisture deposits on the colder wall, collects and runs down and makes a very unpleasant house.

The permeability of the walls will also be affected by papering, painting, and varnishing. "Coating with water-glass," says Lang, "probably in time completely destroys the permeability of a wall, so also does oil-paint, while new, although the cracks which come in the course of time make a considerable difference. When I state that oil-paint is the principal agent in preventing the diffusion and passage through the walls of the watery vapours which originate in domestic processes and respiration, it will be necessary for the science of hygiene to decide whether water-glass and oil-paint will have to be condemned. Size-colours also lessen the permeability considerably, and in proportion to the strength of the size; that used by me was so feebly sized that it lost colour, and yet the amount of air passing through was lessened by one-half; the smallest loss of permeability occurred when lime-colours were used."

In the next place it is also plain that a house

with several free walls will be more easily ventilated in this way than one with less. A detached villa, for example, will permit of this diffusion taking place from all sides.

Then it will be noticed that this natural means of ventilation will come most prominently into force during the colder periods of the year, just at those periods when one seeks to close up, in a wholesale fashion, all ways for the entrance of cold air from the outside and to heat up the interior. The great difference thus produced between the temperatures within and without will develop the diffusion to its greatest amount. A remarkable case in a London house is related by Mr. W. N. Hartley of King's College, London, "which gives a distinct proof of the much greater passage of gas through the walls in winter than summer. A small room occasionally used was noticed sometimes to have an unbearably bad smell; this was never noticed in summer, nor in winter unless a fire was lighted in the room; the drainage was suspected and examined, but was found perfect, yet here was this extraordinarily foul air making its way into the room, whenever the interior was warm and the exterior was cold. The cause was a dust-bin built against one of the walls, and the filtration [diffusion] of the air through this and the house wall into the room."

This natural means of ventilation is in every way desirable, since it permits an exchange of air quite free from draught, and since the passage of the air through the wall robs it of solid impurities. At the same time if walls are porous to air they are also porous to water, and while it is desirable to build them of material that will not interfere with a valuable means of ventilation, it is also necessary so to build them as to afford adequate protection from the weather. Moreover walls permeated with moisture deny a passage to air. Again walls whose pores are occupied by air are bad conductors of heat, air being a very bad conductor, and thus such walls do not readily conduct the heat from the dwelling. On the other hand water is a good conductor of heat, and if the walls are saturated with water, they become good conductors and are very active in reducing the temperature of the house. It is for this reason that houses with damp walls give one so marked a sensation of chilliness. The porosity of walls is, therefore, largely retained and the disadvantages of their being penetrated with water largely reduced by thickness. In a wet climate a thick wall will prevent the access of damp and the loss of heat, and in hot climates it will hinder the heating up of the house by the rays of the sun, under both circumstances assisting in the maintenance of a mean temperature. Double walls would answer the purpose admirably, the two walls being separated by a space of 1½ to 3 inches, and bound together at proper intervals. The passage of damp would be prevented, the layer of air would be an admirable non-conductor, and exchanges between the outer and inner atmospheres would not be interfered with. For exactly similar reasons walls should be lathed before plastering, the plaster, being by the lathing separated from the wall, acts as an inner wall, an air-space existing between the two. Walls plastered without previously being lathed are usually damp.

Not only does exchange of air take place between the outside and inside of a building but it takes place also by the same natural processes between the various portions of a building. The atmosphere of a room is, therefore, affected not only by diffusion between it and the air outside through the walls but also by diffusion through its floor and ceiling between apartments above and below. We all know how an escape of gas in one room is detectable in a room above. This is of special importance in houses provided with cellars, which are so often allowed to lie in a state of dirt and disorder and with no proper means of ventilation. If the cellars are underground, as they so often are, this becomes a matter of very serious importance, demanding careful attention.

Further there is retained by the soil a large quantity of ordinary air and other gases, and the very reasons which should induce one not to interfere with the natural ventilation occurring between the free air of the outside and the air of inhabited houses, would cause one to take steps to prevent exchange of air between the atmosphere of a house and that of the soil on which it is built. This is specially the case, if the ground is a made-up one, which may contain all sorts of refuse, decaying animal and vegetable matter, and effluvia from drains, &c. Such exchange is prevented by the house being provided with a foundation of cement and by a layer of damp-proof material, in the wall above the level of the ground, which adjoins the wall. Slates of glazed earthenware, slates embedded in cement, in asphalt, &c., are used to provide such a "damp-proof course" as it is called, which with the layers of cement ensures both against the passage of soil-air into the house and the rising of damp.

Still further to prevent gases from the soil

entering the house, it is well to ventilate the space between the foundations and the basement floor by means of gratings let into the walls. The need of such precautions is abundantly shown by the fact stated by Pettenkofer, that persons were poisoned in a house by coal-gas, though no coal-gas was laid on to the house. The gas had escaped into the soil at a distance from the house, had travelled 20 feet under the street, and had thus gained access to the foundations and cellars of the house. A case occurred near London in 1874, where coal-gas gained entrance to houses by permeating the soil, the gas coming from a damaged main. It accumulated to such quantity that finally an explosion occurred which demolished one of the houses.

Openings for Ventilation.—We have thus considered the natural exchange that goes on between the warm air of a room and the colder air of the outside, and we have seen that it may be a valuable means of ventilation; what other means usually exist? It is very commonly the case that there is no special provision whatever for the letting in of fresh air, or the letting out of foul air, beyond what can be effected by the opening of a door or window. If a fire is burning it ensures the passing of a current of air through the room. The fresh air enters by every available crack and crevice or ill-fitting joint, under the door, through the key-hole, and by the sides of the window. A sufficiently plentiful supply may gain admission, but it is in an undesirable way, cold currents being produced, and it is in a way not under control. Moreover, with the entry of the air is the entrance of dust, and indeed the direction of the current along a wall, &c., is frequently shown by the dust-track. Now if a sufficiently large opening, communicating with the outside, be made to permit the free entrance of the necessary supply of air, all these irregular air currents will be abolished, and the flow along the open channel can be regulated at pleasure, while various filter arrangements can be employed against dust. Let anyone hold a candle flame opposite the keyhole of the door, in a room which has no special inlet for air, the deviation of the flame will show a strong current. Now let a window be raised slightly to permit free entrance of air, the behaviour of the candle-flame will show that the current through the keyhole has ceased. It is, therefore, desirable that special openings should be made, certainly for the inlet of fresh air, and also for the outlet of foul air, even though a fire acts admirably as an extractor of air.

What, then, are the general principles that should guide one as to the position, size, shape, &c., of these inlet and outlet openings?

The position of air openings is regulated by the fact that heated air rises. The foulest air in a room is nearest the roof, and this in spite of the fact that the foul air contains a considerable proportion of carbonic acid gas, which is a heavy gas, heavier than ordinary air. It is only its greater degree of warmth, as it is expired through the mouth, that causes the polluted air of respiration to ascend. If this foul air, after ascending towards the roof, became cooled, the carbonic acid would descend and would more readily have the opportunity of being breathed over again. The outlet for foul air should then be placed as near the roof as possible. If it were possible, so far as comfort is concerned, to admit the fresh air by an opening near the floor, it would be a natural arrangement. The cold air would enter below, the foul heated air would escape above. But this is not a suitable arrangement, as it would tend to cause chilling of the feet of the occupants of the room. For similar reasons it is undesirable that fresh air should enter at any level which would render it possible for it to strike against any part of the body of a person in the room, and, therefore, it is customary to arrange the inlet opening so that the fresh air enters above the level of persons standing in the room, and to direct it towards the roof, so that it spreads out and is diffused through the apartment.

Inlet Ventilators.—If the chimney is deemed a sufficient means of withdrawing the foul air, then only an inlet tube needs to be provided. It may be placed in the wall near to the ceiling, and it should be so arranged as to direct the current of entering air towards the roof, against which it strikes and is so broken up into a fine shower of fresh air, draughts being thus prevented.

Window Ventilation.—The simple contrivance of having holes cut in one of the topmost panes of a window, which may be opened or closed by a revolving glass disc, on the hit-and-miss principle, is good enough so far as the admission of air is concerned, but it admits direct currents and so occasions draughts. Of window-pane ventilators a better form is that with louvred panes, by means of which the air is directed upwards. Another simple contrivance is to have a slit made in the lower bar of the upper half of the window, running the whole length of the bar, so as to leave a space about a quarter of

an inch at the place where the upper bar of the lower sash and the lower bar of the upper sash meet. This permits of an entering current and directs it upwards. Another method is to fit a bar of wood, about three inches broad or thereby, to the bottom of the lower sash of the window, so that the lower sash is kept raised a couple of inches or so, and yet no air permitted to enter below. The effect of this is that the two sashes do not meet in the middle, as they do when the window is completely shut, and air is thus permitted to enter in an upward stream. If a room is fitted with double windows, ventilation is very easily carried out by keeping the lower sash of the outer window open a few inches, and the upper sash of the inner window down a few inches. The air entering at the bottom of the outer window passes up in the space between the two windows, and enters the room above. This arrangement has a double advantage. The single window is the cause of a great loss of heat to the room. Thus, suppose a room of ordinary size, containing 3000 cubic feet of air, and having two windows with a surface of glass equal to 30 feet. One square foot of glass, it is said, will cool 1·279 cubic feet of air as many degrees per minute as the internal air exceeds the external in temperature. If such a room is occupied by six persons, its air will require renewal four times per hour at least, and the total cooling effect of the glass will, in these circumstances, be such as to represent a constant lowering of temperature of the air in the room equal to 9·5°. Now if the windows be double much of this loss of heat will be prevented, the outer panes preventing the inner being constantly robbed of their heat by the cold external air. Moreover, the entering air, as it passes through the space between the two windows before gaining the room, will be somewhat warmed by contact with the inner panes, and thus the double benefit will be gained. It is always, however, preferable, except where double windows exist, to have a special inlet for fresh air, altogether separate from the window.

The Sheringham ventilator (Fig. 270) is a simple yet cheap and effective apparatus for this purpose. It is an iron box fitted into the wall, near to the ceiling, and communicating directly with the external air. It is provided on the inside with a hopper valve, which may be altogether closed or opened to any desired extent by means of a cord working over pulleys. The valve opens in such a way as to direct the current of air to the roof. The inner opening is larger than the outer, so that the rapidity of the current of air at the outer opening is diminished at the room opening, and the current is spread out as it enters the room. One other advantage of this form of ventilator is that in the event of both outlet and inlet open-

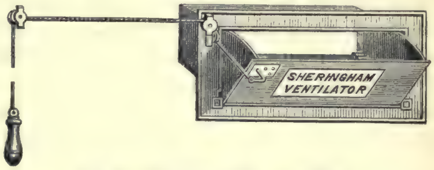


Fig. 270.—Sheringham Patent Ventilator.

ings being provided, it may become an outlet opening, permitting the escape of heated air from the upper part of the room, if fresh air is entering by other channels; and if these other channels are closed, it may again become an inlet opening.

Mr. Pridgin Teale, the surgeon, of Leeds, ventilates his room by means of an opening in the wall near the ceiling, 5 feet by 16, in which is fitted a broad tube. Within this tube is a canvas screen placed diagonally, so that the air is filtered as it passes through, while at the same time the current is slowed and broken up. On the room side he has a Harding's diffuser, an arrangement for spreading out the current into a multitude of tiny streams. The inner opening is also fitted with a door permitting the ventilator to be opened or closed at pleasure. He finds, however, that the arrangement works so well, that it is allowed to remain constantly open, winter and summer.

Another form of inlet ventilator is shown in Fig. 271. It also is fitted into the wall near the ceiling, and communicates directly with the

Fig. 271.—Air Inlet Wall Panel.

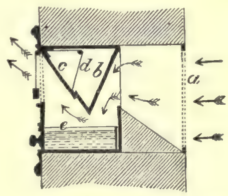


Fig. 272.—Section of Air Inlet Wall Panel.

outside air. A diagram of the arrangement is shown in Fig. 272. At *a* is the opening on the outside by which the air enters; a shield *b* causes the air to be deflected downwards to pass over a trough of water *e* by which the air is cooled, and by which also the air is deprived of a large amount of its solid impurity. The air is then directed upwards towards the ceiling

by the bar in front of the lower part of the inner opening. The valve *c d* is capable of being raised or lowered to regulate the current of air, and the perforated front breaks up the current and diminishes its velocity as it enters the room. Such air-inlet panels may be obtained in many forms, but are all on the same principle. The trough of water may be dispensed with, or it may be filled with some disinfectant, or a filter of gauze may be substituted. A feature of Sheringham's and such ventilators is the ease with which they may be kept clean, a very important matter.

Tobin's Inlet Tubes.—Another method of introducing fresh air is by means of tubes, of a style with which the name of Mr. Tobin, of Leeds, is usually associated. They open directly through the wall on a level with the floor. The tube then rises against the wall to a height above the level of the heads of persons in the room. A regulator is placed in the tube, the handle of which projects at the side, by means

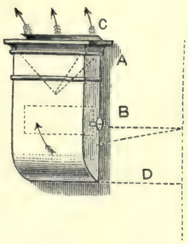


Fig. 273.—Wall Bracket Inlet on Tobin's System.

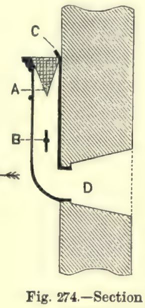


Fig. 274.—Section of Wall Bracket Inlet.

of which the tube can be closed against the current or opened to a greater or less extent. At the opening a projecting lip directs the current upwards and from the wall. In such tubes there is usually a funnel-shaped canvas bag, or similar contrivance, for the purpose of filtering the air. Fig. 273 shows a similar contrivance, in the form of a wall bracket, and Fig. 274 represents it in section. D is the opening in the wall supplied with an outside grating. B is the regulator, A the filter, and C the projecting lip. This bracket would open through the wall above the level of the heads of the inmates of the room. In the case of a tube rising like a pillar or panel in the wall, D would be at the floor line, and the tube would rise inside against the wall as already indicated. These tubes may be made of any ornamental design, as wall pillars, wall panels, wall brackets, &c., so that their real purpose is not apparent, as is evident from Fig. 275. In churches, halls, and very large rooms, pillars supporting beams, galleries, &c., could be utilized for such purposes, the inlet being at the capitals. The difficulty of cleaning such tubes is one of their main disadvantages.

One of these tubes might be employed as an inlet ventilator, and near the ceiling on the op-

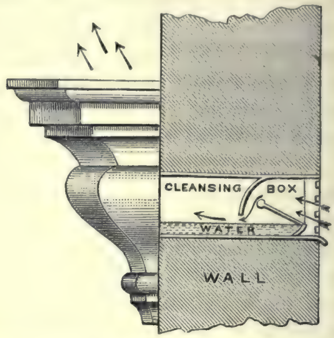


Fig. 275.—Ornamental Wall Bracket Inlet Ventilator, with Arrangement for Purifying the Entering Air.

posite wall, a Sheringham or other similar ventilator might be used as an outlet ventilator for foul air.

Outlet Ventilators.—One situation in which a ventilator for the escape of foul air is frequently placed is in the wall above the fireplace, not far below the cornice. It opens into the chimney, the upward draught causing the ventilator to act. The disadvantage of such a situation is that in the event of a down draught, such as produces back-smoke, smoke from the chimney would be driven through the ventilator into the room. To prevent this, such ventilators are usually supplied with valves of very light material, preferably mica, which close on the slightest stoppage of the upward current.

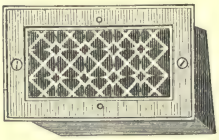


Fig. 276.—Mica-flap Outlet Ventilator (front view).

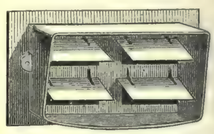


Fig. 277.—Mica-flap Outlet Ventilator (back view).

Fig. 276 gives a front view of such a mica-flap ventilator, and Fig. 277 shows the back view, in which the flaps are seen.

Shaft Ventilators.—In other systems ventilating shafts are used, opening from the ceiling of the space to be ventilated and passing up above the top of the building, such as is diagrammatically represented in Fig. 278. This is the method adopted for large institutions, military hospitals, barracks, &c. When an efficient inlet is also provided difficulties are reduced.

But when there are no special inlets the movements of air in the shafts are much disturbed by the influence of winds, changes of temperature, and so on, which indeed create difficulties

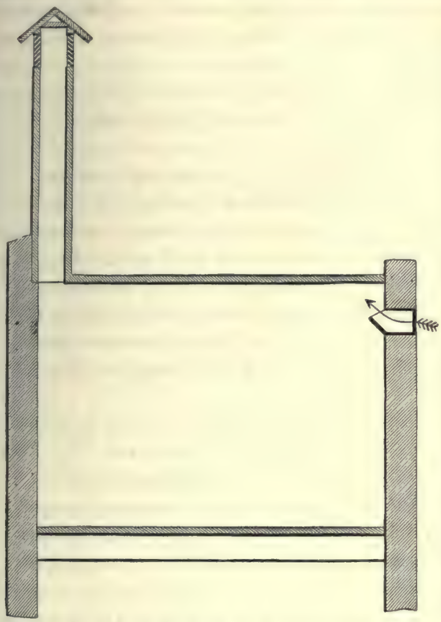


Fig. 278.—Shaft Outlet Ventilator and Sheringham's Inlet Valve.

in every system. But in single shafts there is a tendency to a double current interfering with proper ventilation, one of fresh air passing down and another of foul air escaping, dependent among other circumstances upon the temperature of the space being ventilated, and therefore on the number of persons present in it, and also on the temperature of the shaft.

Watson showed that if a partition completely divides such a shaft into two, a current of fresh air passes down one side and a current of foul air up the other. On this principle M'Kinnell's ventilating shaft is constructed. It consists of two circular tubes, one within the other (Fig. 279), both opening at the ceiling. The inner one rises to a greater height than the outer, and is the outlet tube. The outer or inlet tube is provided with a flange, a little below the ceiling, which directs the entering air along the ceiling and prevents it being poured down on the heads of the inmates of the room or hall. The entering air is somewhat warmed by contact with the inner tube, heated by the escaping foul air. Such shafts need a hood to prevent the descent of rain, and may be provided with cowls turning away from the wind. In such cases the cowl is most efficient when large, with wide projecting mouth.

Shaft systems of ventilation are now usually provided with some arrangement at the head, by means of which the wind may be utilized to exert a suction action for the extraction of the foul air. There are numerous ventilators, designed for such a purpose, in the market. Similar ventilators are sometimes fitted on the roof opening of soil-pipes for the extraction of foul air in the pipe.

The size of the ventilating openings requires to be taken into consideration, and is regulated by the speed which it is desirable the current should possess and the quantity of fresh air to be supplied. This latter, as we have seen, depends upon the number of persons in the space to be ventilated, the number of lights burning, and so on. The production of a movement of air is the result of a difference of temperature. Warm air expands and becomes, therefore, specifically lighter. It therefore rises and is displaced by a volume of cold air flowing in to take its place. The velocity of a current in a chimney or ventilating shaft may be calculated by ascertaining the difference of temperature between the heated and the external air and the height of the chimney. The size of the openings necessary to give a desirable rapidity of current can be calculated out by such data; but as the rapidity will vary with the temperature, so a given size will suit only a definite range of temperature, and therefore the necessity of some means of regulating the size of the opening. The velocity of current at

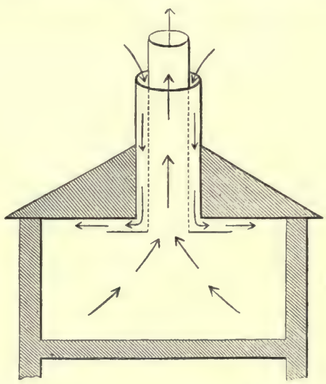


Fig. 279.—M'Kinnell's Ventilating Shaft.

the point of entry of fresh air ought not to exceed, according to De Chaumont, 5 feet per second, and to secure this, "48 square inches of total inlet and outlet area ought to be provided, and this independent of the chimney, if there be an open fireplace." Dr. Parkes says: "It is impossible to fix any size which shall

meet all conditions, even if the influence of wind could be completely excluded, which is impossible. The only way is to adopt a size which will meet most cases, and supply means of altering the size according to circumstances. In this country, a size of 24 square inches per head for inlet, and the same for outlet, seems calculated to meet common conditions; but arrangements should be made for enabling this to be lessened or closed in very cold weather, or if the influence of strong winds is too much felt. Moreover, the size must be in part dependent on the size of the room, because in a small room with many people it is impossible to have the size so great as it would be if each person's space were 48 square inches, unless some portion of the air were warmed. . . . It is desirable to make each individual inlet opening not larger than 48 to 60 square inches in area, or enough for two or three men; and to make the outlet not more than one square foot, or enough for six men. Distribution is more certain with these small openings. It must, however, be borne in mind, that if a calculation is made for a single opening of a certain size, dividing it into a number of smaller openings causes a great loss by increasing the friction. . . . Inlets should not be large and single, but rather numerous and small (from 48 to 60 inches superficial), so that the air may be properly distributed. . . . If there be several they should be, of course, equally distributed through the room, so as to ensure proper mixing of the air."

Ventilation by Chimneys.—It will not be out of place here to note a few practical facts which have been observed regarding the draught produced by chimneys, the chief means of ventilation in many houses. The movement of the air in flues is determined by the differences of temperature of the inside and outside air, as already indicated, and by the length of the flue. Many circumstances, determined by the construction of the chimney, affect the current in it. The movement of the air is retarded by friction against the walls, and, therefore, the more smooth the inner surface is the better will be the draught. Sudden bends, by increasing the friction, diminish the draught. Again, variations in the diameter affect the rapidity of the current, increased diameter slowing it and contractions increasing its speed. Sudden changes in diameter are inadvisable, and whatever change is necessary should be effected gradually, a sudden enlargement having a specially retarding influence on the current by the eddies it creates. A gradual narrowing at the top is quite common and increases the rapidity of the current, while it tends to prevent the descent of cold air; and the throat, or part leading to the fireplace, is also made narrow to aid the velocity there, and prevent the occurrence of a back-draught as well as the escape of unwarmed air into the shaft. Then if several flues enter the one shaft, their direction must be studied. For two currents may meet one another in such a way as almost to destroy the velocity of outflow, and thus make the chimney smoke. All additional flues should, therefore, be made to enter the main shaft as nearly as possible in a vertical direction to prevent such a result. The upper current is also better maintained if the main shaft is somewhat narrowed just below the point of entrance of the additional flue.

A bad draught may be caused by some of the errors in construction indicated. Too wide a flue will occasion it by permitting a current of such diminished velocity that the smoke and air has time to cool, doing away with the difference of temperature which is the cause of any current at all. By permitting the entrance of a large body of unwarmed air, the same effect is produced. A funnel, square in cross section or of the shape of a parallelogram, tends to permit this cooling action to occur; a funnel, circular in section, is best, and in diameter it need not exceed eight inches. If the supply of air to the fire is too little, as it will be when the room is provided with no inlet for fresh air, and when doors and windows are very tight, a bad draught is certain to exist, the remedy for which would be a Sheringham or other form of inlet ventilator. In summer, when no fire is burning in the fireplace, and when the atmosphere of the room is cooler than that of the outside air, the reverse of the ordinary conditions is established and a down-draught is certain. This can be prevented only by valves.

Such faults may be remedied by some form of cap, which makes use of the movement of the wind to produce a suction action, as in the case of Boyle's ventilator or some of the many forms of cowl which move with the wind. A cap is also a protection against the entrance of rain, and against the wind producing a down-draught.

WARMING.

The necessity for the entrance of large quantities of fresh air is almost inseparably associated with that of heating the air, particularly

in climates such as ours. Heat is communicated in three ways, namely, by conduction, by convection, and by radiation.

Conduction of Heat is illustrated in the communication of heat along a poker, one end of which is thrust into the fire. The particles of the poker in the fire pass on the heat, by contact, to the parts outside of the fire, and so the heat travels to the end of the poker. Some substances pass on heat in this way more readily than others; thus metals are all good conductors, some better than others. Wood is not a good conductor, neither is bone nor ivory. Thus in tea-pots made of metal the part of the handle grasped by the hand is usually separated from the main body of the tea-pot by a thin piece of bone or ivory. This prevents the conduction of heat to the handle, which can thus be safely grasped. Air is a bad conductor of heat, so also is water and other liquids, so also are stone, brick, glass, hair, and feathers (see Section V.).

Convection of Heat is the communication of heat by means of the movement of warm particles from one place to another. Thus while a mass of water is not readily heated by conduction, it is quickly heated by convection, that is, currents are quickly set up in the water by which the heat is distributed through the whole mass. When water is being heated in a kettle, as soon as the layer of water touching the bottom of the kettle is warmed by contact, it rises through the cold layers above, and cold water flows in to take its place. This becomes heated and in turn rises, so that the convection currents, set up in the water, speedily cause the whole quantity of water to be warmed. This is specially the way in which heat is communicated by air, which is, as we have said, a bad conductor. No sooner is one portion of air heated than a current is produced, the heated air rises, cold air flows in to take its place, and so the heat is distributed.

Radiation of Heat is not so easily understood. It is independent of air. It is because of radiation of heat from the sun that one is warmed when walking exposed to its direct beams. On a winter's day, when the frost is keen, if the sun is shining brightly upon us, we feel warmed by the rays. The heat we feel is not communicated to us by means of the air, for as soon as we fail to receive the direct rays, as by walking into the shade, we feel again only the keenly cold air. If it had been through the medium of the air that the sun's heat was communicated to us, we would have felt it equally warm in the shade as in the sunshine, for we are surrounded by the same air. Nay if, without moving from the spot where we feel the pleasant warmth poured upon us, the finest possible shield be interposed between us and the direct rays of the sun, if it be only a screen of tissue-paper, we feel at once the same sensation we experienced in passing into the shade. The heat is not communicated to us by the air, for even while we are enjoying the sun's warmth the thermometer may indicate the temperature of the air to be below the freezing point. The heat, then, from the sun is reaching us through the air, but its rays pass through the air without perceptibly warming it. It is only when the heat-rays fall upon a body capable of absorbing them that the body becomes warm. The air does not readily absorb heat; it allows the heat-rays to pass—that is to say, it transmits the heat—but it does not absorb it; but as soon as the heat-rays fall upon our bodies we absorb them and thus feel the warmth.

Open Fireplace or Heated Air.—Now we have stated at this length these methods of communicating heat, because they explain a great difference between sundry systems of warming. For example, if we compare the method of heating an apartment by the ordinary open fireplace with that by driving into it air previously heated, or heated in the apartment itself by hot water or steam pipes, the broad contrast will be readily shown. In the case of the open fireplace the heat is communicated to the apartment by radiation, not by heating the air. The radiant heat from the bright fire passes through the air without perceptibly warming it, and falls upon the walls, chairs, and other furniture, warming them. If a person be sitting within range of these rays he receives them and is also warmed. It is a quite familiar fact that if on a very cold night a person be sitting sideways to the fire, the side of the body towards the fire is unduly warm, while the other side of the body may be feeling half-frozen. It is plain this could not happen if the heat was communicated by the air of the room. It is due to the fact that the radiant heat from the fire is falling on one side and not on the other. Well, then, the walls, furniture, &c., of the room are warmed by the radiant heat, the air of the room not being directly heated at all. The air of the room does, however, become subsequently heated by convection currents. The air in contact with the warm walls, furniture, &c., becomes warmed, rises, and so currents are produced, colder air coming into contact with the walls, &c., and being in

turn warmed, so that by and by the atmosphere of the room becomes warmer, *but it is always less warm than the inclosing walls, furniture, &c.* Moreover, the burning fire demands a large supply of fresh air, which it will draw for itself from every available crevice leading to the outside of the room, and thus the air is continually renewed and its warmth diminished. On the other hand, when air is warmed by some apparatus and admitted to the room, there is no radiant heat, and one breathes warm air. If the heating be accomplished by hot air or steam pipes in the room, or by such contrivances as the German stove, it is again by heating the air that warmth is communicated. Heat does radiate to some extent from the hot pipes and the stove, but the heat is chiefly distributed by the air becoming warmed by contact with the hot pipes, and convection currents being thus produced. Moreover, the absence of the open fireplace does away with the guarantee of a certain amount of ventilation constantly going on, and in the absence of a very efficient system of ventilation by special inlet and outlet openings, the evils of bad air are added to the disadvantage of rarefied air, the disadvantage of a deficient quantity of oxygen with every breath inspired. These are the causes of the languor, want of freshness, feeling of oppression, and headache so common in halls or rooms heated by means of hot pipes, and not provided with a very efficient system of ventilation.

At the same time in cold climates there is almost a necessity for some arrangement for warming to some extent the large volume of air required for efficient ventilation. That is to say, while the open fire is the most desirable and simple means of warming rooms of ordinary size and small halls, it is frequently scarcely sufficient in cold raw climates, or at cold seasons of the year, and various methods have been suggested for supplementing it.

The Construction of Grates.—The ordinary grate, however, is not constructed to produce the full effect the open fire is capable of. As already indicated, it warms a room by radiation, but the ordinary grate is not usually constructed to permit radiation to take place to the fullest possible extent. There are various reasons for this, some of which may be stated. First, the coal is not completely burned. The air does not gain access to the fire in such a way as to produce perfect combustion, not necessarily because of an insufficient supply of air, but because of a bad distribution through the burning mass. Much material, in the shape of soot, smoke, and gases, escapes up the chimney, which would have given off a great deal of heat had complete union with the oxygen of the air been effected. Then, according to General Morin, five-eighths of the heat are not utilized in heating the room, but are lost up the chimney. The material of which the fireplace is made is often not the best for radiating heat into the room, and its shape is not adapted for such a purpose, for example the old large square fireplaces. It was Count Rumford who, in 1796, pointed out the waste of the heating capacity of the fuel which the style of grate then in use occasioned. He brought the grate to the front of the hearth recess, reduced the width of the back of the grate to one-third of that of the recess, and built the back and sides of the grate of non-conducting material, such as brick or fire-clay. An important alteration was that by which the sides of the grate were made to slope outwards from the back, so that when they became hot they radiated their heat into the room. The wide throat of the old chimney was narrowed, so as to diminish the total volume of air drawn into the chimney by which the fireplace was continually being cooled down, and which also secured more complete combustion of the coals. These are the general principles which ought still to guide the construction of fireplaces. Glazed tiles may be used for the back and sides, as they emit the heat more rapidly than unglazed. A fire-brick slab sloping slightly upwards from the back assists the radiation of heat and the combustion of the fuel. Many grates of modern construction are provided with special arrangements to prevent all the cold air entering directly. Part is led from below up flutings on the back, and in other ways, to be delivered partly warmed into the heart of the fire, to ensure complete combustion. Such improved grates also economize fuel.

Teale's "Economizer."—Mr. Pridgin Teale has suggested a very simple arrangement which he maintains effects more complete combustion, causes more heat to be given out to the room, and saves fuel. It has the advantage of being very cheap, and capable of being applied to any form of grate. He removes the ash-pan from under the grate, and incloses that space by an iron plate of a shape to fit the grate, resting on the hearth and rising as high as the bottom bar of the grate. The space below the grate thus becomes a closed chamber; air is not permitted to enter the fire from below at all, and the draught is thus diminished and slower combustion secured. The coal, however, is more com-

pletely burned, for since no cold air enters from below, the bottom layer of coal is kept very hot, so that the cinders become consumed, and the fine ash produced drops through the bottom into the inclosed air space. Then the inclosed air space is a hot-air chamber, giving out considerable heat and maintaining a uniform rate of combustion. The iron shield Mr. Teale calls, on this account, the "Economizer."

All the contrivances noted, however, are simply devices for utilizing to the utmost the radiating power of the open fireplace.

It should be observed further that the heat given out from the open fireplace would be of much greater value for heating an apartment if the fireplace were situated not in an outside wall, owing to which much heat is lost, but in an inside wall. The heat, which, in the former case, is lost by being passed through the wall and given off to the external atmosphere, would, in the latter case, be wholly utilized in warming the atmosphere of the house. This, of course, implies economy in fuel.

The Galton Grate.—We must now refer to a method by which the open fireplace is made use of also to warm the fresh air entering the room for ventilation. The air so warmed should not be heated above 54° to 60° Fahr. By such a contrivance the advantages of the open fireplace are retained and the disadvantages of admitting large volumes of very cold air to the room got rid of. The grate called the "Galton Grate," devised by Captain Galton of the Royal Engineers nearly thirty years ago, is the example of such an arrangement. Behind the grate is a chamber into which pure air from the outside is admitted. The back of the grate is provided with a set of gills, in passing over which the pure air is warmed. This air then passes upwards by a flue alongside of the chimney and enters the room above the fireplace. This chamber and flue are altogether shut off from the grate and chimney and obtain their air from the outside only. There are now many forms of such open fireplaces.

The warmed air entering the room above the chimney-piece is caught by a current passing upwards to the roof in front of the fireplace, and is thus broken up near the ceiling into various currents, so that it is rapidly distributed through the apartment.

Stoves, and specially **Slow-combustion Stoves,** are now being largely employed, in particular for the heating of halls, &c. They may be made of iron or glazed earthenware. The latter is a worse conductor of heat than the former, but it in consequence parts with its heat more slowly and regularly, so that a uniform temperature is more surely maintained by an earthenware or brick stove. The value of such stoves from an economical point of view is due to their internal arrangements. The smoke and gases given off from the burning coal are conducted upwards and downwards within the body of the stove before they are allowed to escape by the chimney, and thus they are caused to part with the main portion of their heat to the material of the stove, which in turn gives it off to the air of the apartment. Then, once the fire has been lighted, the doors are closed, and the air supplied very slowly, so that one charge of fuel will last from morning to night; the heat will be slowly given off, and utilized to the greatest possible extent. Such contrivances, therefore, create no draught of any value for ventilation, while their value for heating purposes being dependent upon the warming of the air, and not on radiant heat, doors and windows are usually kept closed to get the full effect from them. They are, therefore, likely directly to create the temptation to inefficient ventilation. Such stoves are in constant use in Germany for warming purposes, no open fireplaces being used; hence the designation **German Stoves.** Any one who has only experience of their use for warming the atmosphere of a whole house, the stove being in the hall, will not realize their disadvantages to the same extent as one does who has experience of their employment abroad in the living- and sleeping-rooms. When the fire is charged in the afternoon, the doors and windows of the bed-room are carefully closed, and when one enters the room for the night, the atmosphere feels stifling and is almost unendurable. One instinctively rushes to open the window for a draught of fresh air. There is, however, a modification of such stoves by which a pipe carrying fresh air from the outside may be passed through a part of the stove, and allowed to escape at the top into the room, so that a supply of fresh warmed air is obtained. But this implies a larger consumption of fuel, a more rapid combustion in the stove, else heat would not be produced sufficient to warm to any degree the fresh air passed in.

Gas Stoves.—Wherever gas stoves are used it is necessary to ensure that the products of combustion are passed off to the outside and not permitted to escape into the apartment. The gas ranges, now so commonly used for cooking purposes, err in this respect. The lower part of the range, occupied by the oven, is provided

with a flue, by which the products of combustion are conveyed to the outside, but the various gas jets, arranged in ring form &c. just under the grating of the top of the range, give off all the burnt gases into the apartment, and the smell is perceptible immediately after the gas has been lighted. If a gas stove is fitted into the ordinary grate recess, so that all the combustion products escape up the chimney in the ordinary way, the objection is removed; but usually the gas range stands out into the floor at the side of the ordinary grate, in addition to which, or instead of which, it is being employed. This is decidedly objectionable. It is now also common to see an ordinary range adapted for gas, at least to some extent. The oven may be heated by gas, and on the hot plate above the oven, it is also becoming quite usual to fit ring-jets on which a kettle, pot &c. could be boiled. In this way no evil is incurred, for the burnt gases escape up the chimney as the smoke from the ordinary fire. Some of the gas stoves adapted exclusively for warming purposes also exhibit the fault of discharging their burnt gases into the apartment, and these are not to be recommended. Only those should be selected which are provided with a flue; and there are now many forms which can quite easily be fitted into the fireplace of the ordinary grate, discharging their waste up the chimney. Gas stoves of whatever form are not economical, for continuous burning, at the present price of gas. Asbestos stoves heated to redness by gas are so arranged as to give out a large amount of radiant heat, but they are only economical owing to the fact that they can be put out at any moment and relighted with equal rapidity. They are expensive if used for any time on end. If they are used only now and again, for a short period, then they may be more economical than coal, and they save an enormous amount of labour and dirt.

Gas, however, is now being employed for warming the fresh air admitted to a room for ventilation, and may be combined with modifications of inlet tubes such as have been described, and with an open fireplace. Fig. 280 is an illustration of an air inlet tube A, in the interior of which is a small chamber C provided with a gas jet D. This chamber is continued into a pipe B coiling through the compartment, through which pass the heated products of combustion. This pipe may end in a chamber G open to the outside by H, but shut off from the space of the inlet tube, and containing some material for absorbing the waste gases that escape; or the pipe may be carried up the inlet tube J, again to pass out above. The gas jet is supplied with air for its combustion through the openings E and F. Air enters the space of the inlet tube, and is warmed as it passes through it by contact with the coiled pipe. It may be filtered before passing into the room by the conical canvas bag shown. The entering air is admitted through an opening guarded by a shutter, K, which is raised or lowered to any desired extent by the cord passing over the pulley L, and counterpoised by the weight, M.

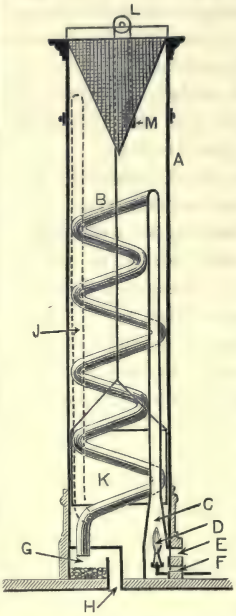


Fig. 280.—Air Inlet Tube fitted with Fresh Air Warming Arrangement (Boyle).

In concluding these paragraphs on the very difficult subject of ventilation and warming, the author does not wish to ignore the fact that the review of some of the chief methods now adopted for introducing an abundant supply of fresh air into apartments without unduly lowering the temperature, while it may be very valuable to the man who wishes to build his own house or already owns one, may not afford much aid to those who are simply tenants and have neither the means nor the opportunity of adopting any of the more elaborate systems. They may wish at the same time, and may be able to adopt, some simple and inexpensive method, as far as possible to achieve the ends desired. To such it may be said, that if they will give themselves a little trouble in the securing of grates which are constructed to give out the greatest amount of heat, and which are now almost as readily obtained as those of bad construction, and if, in addition, they can fit up such an inlet regulating ventilator as Sheringham's or others of like construction, or Teale's, they will do much to accomplish what is required.

Section IV.—HOUSE DRAINAGE.

Waste from Dwellings:
Its Character and its Destruction by Natural Agencies.
The Disposal of Waste from Dwellings:
Drains and Sewers;
Cesspools;
Sewage Gas—Its Effects and Its Dangers;
Traps—The Syphon—Access Syphon—Hart Trap—Disconnecting Traps;
Bad Forms of Traps—The Dipstone Trap—The Bell Trap;
Ventilation of Traps and Drains;
Drain Pipes, Sewers, &c.—Proper Material for Drains—Mode of Joining Pipes—Position of Pipes.
Common Defects in House Drainage:
Defects in the Soil-pipe;
Defects in Waste Pipes;
Defects to be looked for in Drains—How a House Ought, and Ought not, to be Drained.
The Testing of Drains.
The Flushing of Drains.
The Water-closet:
The Pan-closet, Hopper Closet;
Wash-out and Valve Closets;
The Connection of Water-closet and Cistern.
Sinks.
Drainage and Water Supply.
Cisterns—The Material of their Construction—Their Position and Protection from Frost.
Dry Methods of Removing Excreta:
Moule's, Morrell's, and Goux' Arrangements.
Sanitary Maxims.

HOUSE DRAINAGE.

The Nature of Waste from Dwellings.—In this section we have to consider various methods for the removal of waste from dwellings. What is the nature of that waste? It is partly liquid and partly solid. The liquid portion consists of waste water from baths, sinks, wash-hand basins &c., and we may also add rain-water caught on the roof and led off by pipes. In all this there is both animal and vegetable matter, capable under certain conditions of temperature of undergoing rapid decomposition and giving off putrefactive gases. There remains to be added the urine voided from the bodies of the inmates of the house, which very speedily decomposes. The solid portions of the waste consist of refuse of food, both animal and vegetable, dust, ashes &c., and the solid waste passed off from the bowels of the inmates. In primitive conditions, and in places where the population is sparse, there is no great difficulty in suitably disposing of such waste. The organic material, both animal and vegetable, which such waste contains, in ordinary course undergoes decomposition or putrefaction. This, as has been pointed out at length in Section XIII., Part I., is the process by which complex bodies are broken down into simple bodies or elementary substances, in which form they are again useful for the nourishment of plants, in which form, also, they are harmless. Thus the urine contains urea, the waste of nitrogenous foods consumed in the body. If it be exposed for a time to the air we know it becomes offensively ammoniacal in smell, because the urea has become transformed into carbonate of ammonia, and if it be thrown upon the soil the nitrogen it contains is available for the life and growth of the plant. So it is with the other organic substances. This process of breaking down, of reduction to simple, inoffensive, useful, substances, is accomplished chiefly by the agency of the oxygen of the air; it is essentially a process of combustion, of oxidation, of burning, and it cannot be accomplished unless there is free exposure to air, or free exposure, under suitable conditions, to substances which will yield the needed oxygen in suitable quantity. If the waste be freely exposed to the open air, this process of oxidation will in good time be accomplished, and then the waste becomes valuable for scattering over fields, and so on, to enrich the soil. Suppose the waste in its fresh state be scattered over the soil, it is freely exposed to the air, the liquid portion which sinks into the soil, meets the air in the soil, the ground air, and gets the necessary oxygen. This distribution

over the soil can, however, be accomplished only during certain periods of the year, and it may be, therefore, necessary to accumulate it in heaps till the period when it can be used. This also may be done without harm, if the accumulation be made at a proper distance from the dwelling. If the waste be cast into a stream, it is rapidly carried off. In the water it also undergoes combustion, not because of the water itself, but by the agency of the oxygen, dissolved in the water to the extent of something like 2½ cubic inches to the gallon. In time no sewage, as such, will be found in the stream; it has all undergone oxidation. Where the population is sparse, then, the resources of nature are quite sufficient to deal with the waste from human habitations. As men congregate, however, the circumstances are changed. The bulk of waste becomes too great for the natural resources of the place to cope with. It becomes necessary to make arrangements for its removal to great distances. If it be cast into a stream, the current may be sufficient to carry it rapidly away, but then the stream is seriously polluted, and if no great distance separates the place where the waste enters from another, lower down the stream, where other dwellings exist, there is no time for natural purification to occur. The magnitude of the difficulty becomes enormous when the waste of a town has to be dealt with. A few figures will show this clearly. If we consider simply the waste cast off from the human body, 40 ounces per day of urine and 2½ ounces per day of solid excrement per head is a low average for both sexes and all ages. This makes, for a population of 1000 persons, 260 gallons of urine and 156 pounds of solids per day, or 91,250 gallons of urine and 25 tons of solid excrement per year. If there be added to this waste water of all kinds and solid refuse, the amount to be disposed of becomes enormous. In order to simplify our consideration of the question, we shall begin by considering the disposal of the human waste, or excreta (from Latin *excerno*, to separate out), along with waste water. It is necessary to provide channels for waste or slop water from houses, at any rate, and we shall consider that human excreta both liquid and solid, are cast into the same channels to be carried off in the same way. We can consider later other methods proposed for dealing with solid human excrement, as well as the means of disposing of the other solid refuse of the dwelling.

This system of casting into the same channel waste water from the dwelling as well as human excreta is common, because the water carriage thus provided is an easy method of removing the solid excrement. It is efficient also and not expensive. The channels may ultimately be made to discharge their contents into a river or into the sea, or into tanks where the collected material may undergo some purification by chemical means, to be afterwards disposed of in some convenient way, or it may be collected into reservoirs and thence distributed over soil for manurial purposes.

Disposal of Waste.—Our present concern is its speedy removal from the dwelling. This is apparently simple enough. To the sink, wash-hand basin, water-closet &c., a pipe is connected. These pipes join one another and form a common pipe leading out of the house, or they are branches of a common pipe, passing through and ultimately leaving the house. Into this same main pipe pass pipes collecting the rain-water from the roof. The rain-water pipe may pass down one side of the house, then below the basement to join the main pipe at the other side. Thus rain-water from the roof, waste water from bath-rooms, dressing-rooms, kitchens, and sculleries, and excreta from water-closets all enter one common pipe either within the house, or the pipes, which they enter, ultimately join one common pipe outside the house. Moreover the pipe from one house or one tenement joins that from another house or tenement, the common pipe being now enlarged for the purpose, and as this passes onwards it receives additions and branches from other houses &c., becoming larger as it proceeds and carrying ever-increasing quantities of waste. The pipes inside the house are called **drains**, and the same term is applied to the main pipes leading from the house or tenement, but the larger pipes or channels into which the drains from several houses pass are called **sewers** or **common sewers**. The sewers pass on until they open let us say into the river, into which they discharge their contents.

Now let us consider what this apparently simple system means. The material in the drains and sewers is covered up, excluded from the air, until it is discharged into the river. It may have to pass through miles of piping before its exit. Air is present in the drains and sewers to some extent and also in the water, and thus some amount of oxidation can occur, but the oxygen obtainable is a mere fraction of what is necessary, and thus the natural process of reduction of the organic substances to simple and harmless elementary bodies cannot occur Meanwhile, however, putrefaction is not pre-

vented, decomposition proceeds to some extent, and putrid gases and all the noxious effluvia capable of being given off from such mixed ingredients fill the pipes. If the connection of the house drains with the sewers is the simple one indicated, it is plain that there is no barrier to the passage of the sewer gas into the house. The waste as it enters the house drains is not yet in a state of putrefaction and it is carried rapidly away by the water, so that thus far no harm can arise. But the atmosphere of the house is in direct communication with the atmosphere of the drains and sewers, and that of the house being warmer, there is an actual suction exerted upon the sewer gas, drawing it into the house. Moreover that is not all. Such a simple means of connection implies that the atmosphere of one house is in direct communication with another through the drain-pipes, which are a sort of secret subterranean passage, and a man who is scrupulous about having fresh air in his own house may yet enjoy the foul air of his neighbours through this unsuspected means of communication.

Cesspools.—When it was not possible to lead the sewage off by a stream it used to be the practice, and indeed in a restricted sense is so still, to build a cesspool, into which the drains from the house were carried. These cesspools were built of brick or other porous material, and allowed the liquid portion of the material to ooze into the ground, the solids being retained. When the cesspool was full, the retained solids were available as manure for field or garden purposes. Even where the drains of the house were connected with a general sewerage system for removing the sewage, cesspools were interposed before the drains joined the sewers for the interception of the solid portions, the liquid parts being provided with an overflow into the sewers. It was not even customary to empty the cesspool when full, unless there were obvious advantages by doing so in the securing of manure, but, to save trouble, when one cesspool was full a new one was dug, and the sewage conducted into it, the old one being simply covered over. Not only was this usual in country districts and at a distance from the house, but it was also common in towns, for example, in London, and the cesspool was actually dug in the ground covered by the house itself, all the sewage from the house being conducted into it. When one was full, a new one was dug. Thus the late Mr. Eassie writes: "Many of these cesspools are to be found in the older houses of London in the basement, and oftentimes under the kitchen floor. . . . The custom was that when one cesspool was full another should be made, and thus a great many of these receptacles are discovered in one house. . . . It is not uncommon to find cases where the house was built first, and, for want of a suitable fall, the cesspool dug out inside the house. This was the case especially in large mansions with ample cellarage room, and I have discovered and removed as many as eighteen cesspools in one mansion. . . . On one occasion I laid bare five of them, just outside the walls of a residence, and they averaged forty feet in depth! . . . There are in London yet thousands of houses which drain into cesspools, and have only the overflows taken into the sewer. As a matter of course all these cesspools should be abolished, and when a block of old houses is pulled down in a city like London, the whole site should be ploughed up in a search for these old receptacles, as otherwise some of them may come to be left inside the walls of the new house."

Under no circumstances ought cesspools be allowed to exist in towns or where there are numerous houses in immediate proximity to one another. In the country they may be unavoidable; but if so they ought to be so constructed and situated as to do away with the risks attendant upon them in ordinary circumstances. Suppose a country house built upon a slope, and the sewage carried to a cesspool at some distance down the slope, and this at a considerable distance not only from the house but below the house level, and suppose that still below this there spread out fields under cultivation, then it will be admitted that, provided the house pipes are properly disconnected from the cesspool, as described on p. 709, no harm can possibly arise from the cesspool being built of porous material and permitting the sewage to ooze through it into the field below, where it will enrich the soil and fertilize the crops. If, however, at any subsequent period these fields should come to be feued for villas or other dwellings, the sewage filtering down on them from behind could no longer be tolerated. Where, however, there is no proper fall the cesspool must be water-tight, else the escaping fluid permeating the soil would reach the foundations of the house, allowing unhealthy emanations to reach the dwelling, unless the cesspool were at a great distance. It might also gain access to the water supply and pollute it, almost certainly if the water were obtained from a neighbouring well. The cesspool should then be water-tight, it should be

properly ventilated, and the inlet pipe should deliver the sewage through a disconnecting arrangement, to ensure the impossibility of sewage gas passing up the drains to the house. It is deemed also best to lead the sewage through some straining tank, which will permit only the liquid sewage to pass to the cesspool. In such a case the intercepted solids should be collected daily and mixed with earth and perhaps some material to remove smells, and then made use of for manurial purposes. The liquids collected in the tanks would require either to be at regular intervals pumped out and carried away, or some arrangement might be adopted whereby the liquid could be led away into pipes and used for irrigating purposes, the pipes starting from the cesspool being for some distance of glazed earthenware, passing into ordinary agricultural pipes.

Dangers of Sewage Gas.—To return, however, to what we have described as the apparently simple and easy method of removing sewage from a dwelling by pipes in direct communication with the interior of the dwelling. What are the evils of such a system? Let us suppose also that these pipes are directly connected with a cesspool either inside or outside the house. In such circumstances, as already said, sewage gas inevitably gains access to the dwelling. What is the nature of this sewage gas? It contains the ingredients of common air, oxygen, nitrogen and carbonic acid gas, the oxygen in less proportion and the carbonic acid gas in greater proportion than ordinary atmospheric air. It also contains gases from the decomposing sewage, marsh-gas or carburetted hydrogen, sulphuretted hydrogen in small quantity, that horribly fetid gas which gives the smell to rotten eggs, and ammoniacal vapours. The quantity of these noxious gases varies with the construction of the drains and sewers and with the amount of ventilation provided for them. Where the ventilation is good these gases may exist in extremely minute quantity, scarcely appreciable. But there is besides fetid organic matter in the sewer gas, whose character has not been precisely determined, but which imparts to the sewer gas its specially hurtful property to health. Even when such fetid organic matters are in such minute quantity as not to be detected by the senses they are yet capable of doing much harm to persons breathing for any time the atmosphere contaminated by them. Let us now ask what effects does such sewer gas produce upon the body. Can emanations from drains occasion typhoid fever, diphtheria, cholera, blood-poisoning, as is so often alleged? This question would be answered in different ways by different people. I shall endeavour to answer it in a way consistent with recent discoveries regarding the causes of these special diseases. If we are to accept as true the modern investigations regarding germs and their part in the production of disease, and everyone accepts them as true, then scarlet fever, measles, diphtheria, typhoid fever, cholera &c. must be held to be the result of the activity within the body of the particular germs of the particular disease, introduced from without, just as a crop of barley, corn, &c. can only be produced from a soil in which their seeds have been sown. Further, just as "men do not gather grapes of thorns, nor figs of thistles," so it has never yet been found that the germs or seeds of one disease can by any peculiarity of circumstance produce another disease. Measles cannot "pass into" scarlet fever nor scarlet fever into diphtheria. If a patient recovering from scarlet fever is attacked by diphtheria, we can only conclude that he has received into his body not only the seeds of scarlet fever, but also the seeds of diphtheria, however impossible it may be to discover how they have reached him. Moreover if a person is attacked by measles &c. we are compelled to conclude that the germs or seeds of measles have gained entrance to his body, just as if potatoes or corn spring up in a field we say the seed must have got into the soil, whether anyone has been known to sow it or not. To say that a child caught cold, and it "turned into" diphtheria is, according to modern science, as absurd as it would be to say snow fell on a field and from it there sprang up turnips. This being understood let us, in the first place, suppose that a group of houses drain into a common sewer, and that into that sewer there has been discharged only the ordinary simple excreta of the dwellings, no disease being in the houses and, therefore, no excreta containing disease germs of any kind gaining entrance to the drains. Suppose these drains are so constructed that sewer gas from them passes into every one of the houses, what evils may it do? Let us suppose that the inmates of the houses are all, to start with, in the enjoyment of excellent health, living regular lives, with good food, good water supply, uncontaminated, and with plenty of outdoor life and exercise. Then they may live for years in the houses and finally leave it for some other abode entirely unaware of the unhealthy condition in which it actually is. The natural healthy body, that is to say, has a well-marked

resisting power to unhealthy conditions. But if any of the inmates are debarred from going out for prolonged periods, then the constant living in the contaminated atmosphere is likely enough to tell, almost certainly will tell, sooner or later, though perhaps only in vague ways. It is commonly the women, whose duties keep them at home, and not the men, whose business continually takes them out of the house, who show the first indications of any insanitary condition. But in particular children are readily affected, and specially young children. They have much less resisting power; and young children, not yet of school age, are so apt, because of weather conditions, to be shut up for many days at a time in the house that they are often the first to appear to be not in a satisfactory state of health. So that it is in wet weather signs of disease are likely to appear, and in cold weather when doors and windows are kept shut and there is less communication with the pure air of the outside. When, however, the insanitary condition of the house asserts itself it will not be by the appearance of a specific disease, such as diphtheria, typhoid fever &c., for we have assumed that there is no way by which the germs of such diseases could enter the drains. Let it be observed that we do not say such diseases may not appear in any of the households, we only say such diseases cannot arise *from the sewer gas* which is gaining entrance to the house. If such diseases do appear it is because they have been communicated in some other way, by infection from some person who has suffered from the disease or has been in its immediate neighbourhood. Further let it be noticed that persons living in a badly-drained house are all the more apt to fall victims to any of these specific diseases they may meet outside, because the frequent breathing of the sewage-tainted air has diminished their resistance to disease. *In short the emanations from simple sewage cannot produce a specific disease, but they can act injuriously upon the general health of the inmates of the houses producing disorder and disturbance of a variety of kinds, to be noted immediately, and diminishing the natural disease-resisting power of the healthy body, so that the person is a fit subject for taking any disease he may be exposed to; and they act thus most particularly upon any inmates of the house who have little outdoor exercise such as women and young children.* In another way also the sewage-tainted air may prove greatly injurious. If one of the inmates has been seized with illness, has caught, for example, a severe cold, or has been seized with inflammation of the lungs, then his general vigour is reduced, the foul air has its opportunity, and seriously delays and impairs his recovery. Or again the wife is confined of a child in the house, and her recovery is neither so speedy nor so satisfactory as everyone had expected. Her resistance to unhealthy conditions is diminished and so the foul air has its full effect upon her. In all these vague, ill-defined, ill-understood, and unsuspected, ways are sewage emanations daily, aye hourly, affecting the health, the vigour, the life, of large masses of the people, specially in large towns, and there are few who think of it, fewer who know of it, and many who laugh at the notion of it. Yet the author could give instance after instance, from his own experience, in which the operation of the sewage gas has been made out as conclusively as a mathematical demonstration.

But simple sewage emanations may do more than this. They not only diminish disease-resisting power by lowering the vigour of the general system, they not only take advantage of a general system lowered by other causes, but they produce actual diseases, *though of a non-specific character*, and specially, as already said, in those most exposed for long periods to their influence. In adults the symptoms are often only those of a general *malaise*, of a general state of ill-health, such as want of appetite, bad digestion, headache, pallor &c. Frequent sore-throat, sickness and vomiting are common. Marked disorder of the stomach and bowels, purging and diarrhœa, are also consequences. In children very marked symptoms are frequent, such as severe sickness, and vomiting and high fever are quite common, as well as less-defined symptoms of general ill-health, decline of vigour, and so on.

In the next place let us suppose that the sewage is not of the simple kind we have at first assumed. We shall take it for granted that in a house connected with a system of drains, in direct communication with all the other houses discharging into the system, there are one or more cases of some specific disease, such as scarlet fever, diphtheria or typhoid fever, or that there are cases of several of these diseases in different houses of the system. Then the excreta of these patients are cast into the drains. Into the sewage there gain entrance the germs or seeds of these diseases, some of which may multiply there. If the drains are not properly flushed, or if there is a block anywhere, the sewage may become charged with the germs, and it is at least possible that by the bursting of bubbles

of gas, produced by decomposition, germs may become disseminated in the sewer air, and may be drawn into the houses connected with the drains. If the drains are badly laid or the sewers are badly constructed, leakage will take place into the soil, and if the water supply be drawn from wells in the neighbourhood, the water will almost certainly become contaminated and an epidemic is nearly a certainty. Diarrhœa, dysentery, typhoid fever and cholera have thus been propagated. But that these diseases can be propagated by the sewer gas alone, in such circumstances, seems from numerous experiences almost certain. At the very least the risk is enormous. Besides the diseases named diphtheria and a form of inflammation of the lungs (epidemic pneumonia) have been traced to such polluted air. In 1888 an epidemic broke out in an industrial institution in Glasgow in which over 60 boys were attacked, four dying after a few hours' illness. A form of inflammation of the lungs was characteristic of this epidemic. Careful investigation laid the blame on the sanitary arrangements. The institution was in the immediate neighbourhood of an old burial-ground, effluvia from the soil and from the drains gained access to the building, and school-rooms and dormitories were not supplied with pure air sufficient for the number of inmates. The conclusion seemed irresistible that these conditions were the cause of the outbreak. Many more illustrations could be given of a similar kind. Instances are numerous where the opening of blocked drains, old cesspools, &c., has been attended by epidemic fevers, with fatal results.

Sewage gas, pure and simple, is then injurious to health and productive of disease, how enormously is the danger increased from emanations from sewers, into which discharges from multitudes of houses, including the excreta from probably a great variety of diseases, are poured? It is absolutely necessary, then, that some means be provided which, while permitting the free and rapid escape of waste from dwellings into drains and sewers, shall effectually guard against the possibility of foul air from the drains and sewers gaining access to the houses. For this purpose two means are adopted, one seeks by the use of appliances called traps to intercept the backward passage of sewage gas, and the other seeks by ventilating the drain-pipes to have the air within them constantly as pure and fresh as possible. We shall now describe in detail the different appliances and their method of application.

Traps. The simplest form of trap is the **syphon**, shown in Fig. 281. It is a simple dip in the pipe, the effect of which is to retain a quantity of water which acts as a seal preventing the backward passage of air from the drain into the house. There are possible objections to this kind of trap. If it is shallow it may readily

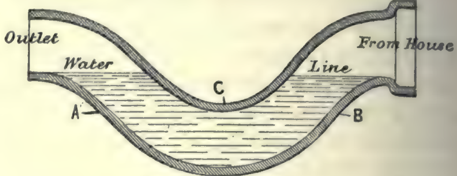


Fig. 281.—Syphon Trap.

be rendered useless. For it is to be noticed that the effective barrier to the passage of gas is the layer of water above the line A B. If, by evaporation or otherwise, the water fall to the level of the lowest part of the bend C, that is, the level indicated by the line at B, the slightest further diminution of water will open a way for the gas from the outlet side through the bend to the house. This might happen if the bend were shallow and the trap small. Further if the pipe be a small one the water in the trap may be syphoned off. If the drain below the trap be running full the suction action exerted by the mass of running water may draw the water from the trap and leave it wholly or partially empty, so that there would be no longer any obstacle to the backward passage of gas. These evils are overcome by ventilating the trap as explained further on. But suppose some obstruction to the outflow further down the drain causing some retention of sewage and the development of a large quantity of gas, the pressure of gas might so increase on the outlet

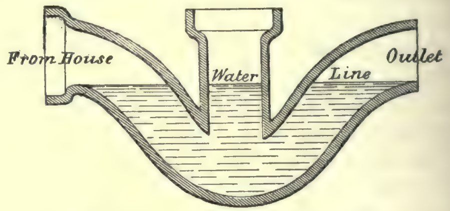


Fig. 282.—Common Lying Trap or Access Syphon.

side as to impregnate the water, and perhaps cause the gas to bubble through the water and so escape into the house. This is also met by ventilating the trap, as shown in Fig. 283.

The **access syphon** is shown in one form in Fig. 282. The additional pipe is let into the centre of the bend. If it comes up to the level of the surface the top may be covered with

a grating and then it acts as a ventilator. It is usually simply covered with a slab of stone and is then used for an inspection or cleaning "eye," permitting in such a case no ventilation. It is, however, not a very good kind to employ. Its position is such that floating excreta are apt to be retained in the added tube, not being swept out by flushing water, and undergoing there decomposition.

Ventilating Trap.—A form of ventilating trap is shown in Fig. 283, where A is the inlet pipe from the house, B is the outlet to the drain, the two being cut off from one another

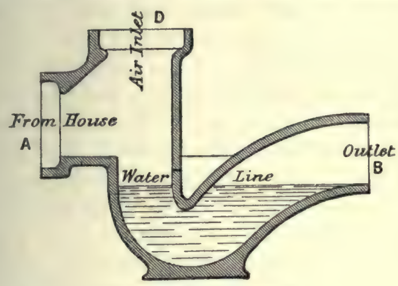


Fig. 283.—Ventilating Trap.

by the trapping water. The ventilating shaft opens at D, and is fitted with a grating. This is the general form of trap for use outside a house. It practically cuts off the house-pipes altogether from the outside drains, the air-chamber disconnecting the two systems. This trap is, therefore, also called a **disconnecting** trap. It is placed outside the house on the soil-pipe drain at a little distance from the house. If it cannot be taken any distance from the house wall, care should at least be exercised that the grating is not in the immediate neighbourhood of a door or window, else a smell will certainly be felt from it, and be occasionally wafted into the house. Fig. 284 shows a similar trap (Buchan's) with an additional opening D for access for cleaning purposes. The cover of D should be fixed down with mortar, and a small brick chamber built up to the ground level, covered with a slab, so that access can be had. Note that by mistake this opening D is sometimes made the ventilating opening, and is covered by a grating. It ought not to be so. C is the opening to be covered by a grating. With such an arrangement, supposing the waste water from baths, sinks &c. as well as rain-water from the roof, to be carried off by a pipe, separate from the soil-pipe, such a pipe could discharge in the open air, over the grating of the ventilating trap. Thus neither the soil nor waste-pipes could be the means of carrying sewage gas backwards into the house. It is not desirable, however, that soil, waste and rain water should pass through the same ventilating trap in the immediate proximity of the house. The soil-pipe should be separate altogether from the waste and rain-water pipes, and these latter should be cut off from the soil-pipe drain by a separate ventilating trap, as shown in detail on *fig. 1*, Plate IX[b]. Where, however, from the construction of the house and the arrangement of its drainage, such is not possible, as in some tenement houses, the above arrangement should *at least* be carried out.

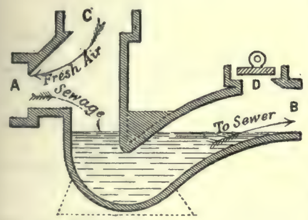


Fig. 284.—Buchan's Ventilating Trap, with Access Pipe.

The **Hart Trap** (Fig. 285) is a recent form of trap, advocated by sanitary engineers for disconnecting bath, rain-water, and such waste pipes from drains. It also is a ventilating trap. It is placed at the foot of the waste pipe, which discharges openly immediately below the level of the ventilating grating. The shape of the trapping portion is such as to secure a complete flushing of the trap, and a thorough washing out of all solid material into the drain.

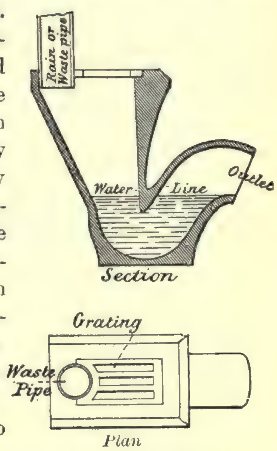


Fig. 285.—The Hart Trap.

The **Gully Trap** is a form of disconnecting trap, placed outside the house in a yard &c., into which rain or waste pipes open, either above or immediately below the ventilating grating. Its form and arrangement are represented in Fig. 286. It is used where one desires to prevent the entrance into the drain of material liable to silt up and block the drain, such material as may be washed down from roof

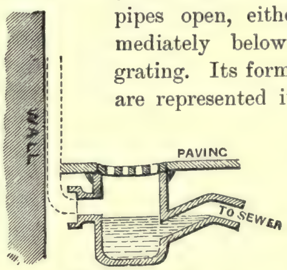


Fig. 286.—Gully Trap.

gutters, or washed in from yard sweepings &c., and which can be removed from time to time as it collects. In the case of the trap for a soil-pipe the shape is not the same, being such that the flushing water will wash everything down into the drain and prevent the interception of any solid material.

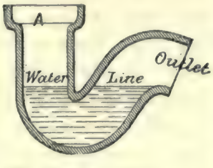


Fig. 287.—Syphon trap Surface Water.

A **Syphon-trap** for pipes, placed to receive surface water, is shown in Fig. 287. The top A is provided with a stoneware grating through which surface water passes.

Bad Forms of Traps.—The general form of trap of greatest use having been indicated, it may be well to give a warning against the use of some, whose employment is more likely to be attended by evil than good. Fig. 288 represents a form of trap which is a modification of the old form of cesspool. It is simply a cesspool, from the roof of which a slab of stone dips down

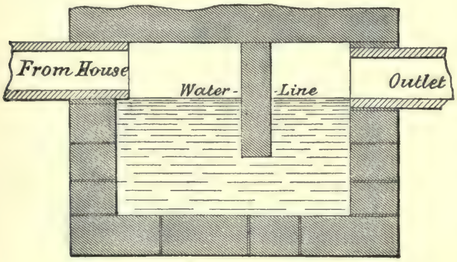


Fig. 288.—Dipstone-trap.

far enough to be below the level of the outlet-pipe, so that it enters the water of the cesspool. The effect of this is completely to divide the cesspool above the water into two chambers, not communicating with one another except through the water. Sewage gas passing up by the outlet-pipe would thus be unable to pass to the inlet-pipe. This is the **Dipstone-trap.** It is an exceedingly bad form, because excreta and decomposing material are certain to be retained in the bottom, because of the very shape of the cesspool, and foul gases will pass off directly on the side of the inlet-pipe.

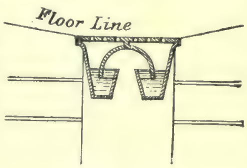


Fig. 289.—Bell-trap.

The **Bell-trap** (Fig. 289) shows a form of trap condemned by almost everyone, and yet very extensively used for carrying off the surface water from outhouses, dairies, washing-houses &c. It is quite commonly found in the basement of houses, where there are stone floors, and a pipe is laid to carry off water running upon them. It is called the **bell-trap**, because of the shape of the cover. It is a square box-shaped trap into which the drain opens, as shown. The box is covered by a grating, to the under surface of which is attached a cup or bell-shaped piece. Water is retained in the box till it rises to the level of the opening of the drain, when it passes down. The cup projects downwards lower than this level and thus dips into the water. While water can pass freely through the grating, over the bell and enter the drain, sewage gas is prevented by the layer of water between the opening of the drain-pipe and the rim of the bell from gaining the grating and passing into the house. When such a trap is in a washing-house floor, to carry off the water with which the floor is flushed, it is quite common for it to become blocked by the dirt &c. washed in, and then it is common, in order to let the water away, for servants and others to scrape away the cement from the edge of the grating and lift it a little. The bell is thus lifted out of the water and communication between the house and the drain is made perfectly open. Moreover it requires very little water to fill the trap; some of them hold little more than a teacupful. The consequence is that the evaporation of a small quantity of water will so diminish the amount in the trap that the entrance to the drain is completely exposed, and the seal is no longer effective. Such a trap would, therefore, be the worst possible, where frequent fresh supply of water does not occur, or where the heat is so great that rapid evaporation occurs, as in the floor of a furnace-room. So apt is this kind of trap to become inefficient that it is now universally condemned, and ought never to be used inside a dwelling, or dairy, or laundry.

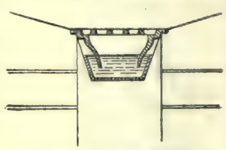


Fig. 290.—Liverpool Bell-trap.

The **Liverpool trap** is another form of the bell-trap, and open to the same objections. Fig. 290.

Ventilation of Traps and Drains is the second condition now invariably insisted on in any system of drainage designed to meet modern sanitary requirements. This ensures the continual removal of foul effluvia from the pipes &c. by a constant current of fresh air. For it is to be observed that efficient ventilation implies not only that there shall be a way of escape provided for foul gas, so that it can never

accumulate so as to force the trapping water, but also that an inlet for fresh air shall also be provided, so that there shall be an actual current to remove foul air and keep the atmosphere in the pipes constantly as pure as possible. How are these objects accomplished? Inside the house all traps should have a ventilating pipe, such as is shown in the case of nearly every house-trap in Plate IX[b]. The ventilating pipe either itself passes up to open on the roof, or opens into a pipe which is continued to the roof. All outside traps should be constructed on the principle illustrated in Fig. 284. It is evident from these figures that no accumulation of gas can occur in such traps. Fig. 291 illustrates how, with such arrangements, a constant fresh-air current is secured. It represents three water-closets, A, B, and C, on the three floors of a house, discharging into the same soil-pipe, S S. At the foot the soil-pipe is provided with a disconnecting trap T by which it is cut off from the sewer. But if the soil-pipe terminated at X, which it might naturally be supposed to do, there could be no current through the soil-pipe. When, however, the soil-pipe is continued upwards, full size, to open at the roof, then air entering through the trap grating G passes right up the pipe, clearing out all foul air and securing efficient ventilation. In the same way traps connected with wash-hand basins, baths, sinks, &c. should have a pipe connected with a main ventilating pipe open both at the foot and top to secure the same end.

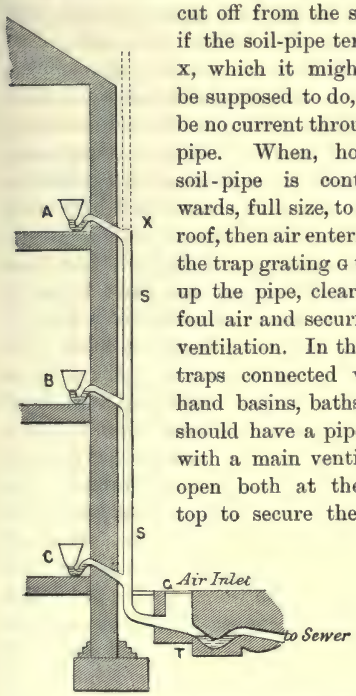


Fig. 291.—Faulty Method of Disconnecting and Ventilating Soil-pipe.

This is further illustrated in *fig. 1*, Plate IX[b].

Drain-pipes, Sewers &c.—Traps, however well devised and ventilated are only one means to the end desired, namely a house free from sewage emanation. One is too apt to think that in a multitude of traps is safety, and to ignore other equally important means of securing proper drainage. Strict attention must also be paid to the drain-pipes, the material of which they are made, the position in which they are laid, the manner in which one length of pipe is connected to another, and in which one drain joins another, and so on.

Material of Pipes.—Pipes inside the house (called **house-pipes** to distinguish from the pipes outside leading to the sewer, to which it is desirable to restrict the term **drain-pipes,** to avoid confusion) are usually made of lead or iron. Lead is very commonly used for greater ease of manipulation. The pipes should, in such a case, be made of drawn lead rather than soldered or seamed lead. Lead pipes for use inside should be $\frac{1}{8}$th inch thick, and should weigh 8 pounds per foot. Junctions should be made by means of wiped joints. Iron pipes are objected to by some because of their rough interior surface giving points of adhesion for particles of soil. When they are used they ought to be of the best quality and of smooth finish, and a porcelain-lined pipe is to be had, recommended for its cleanliness and durability. Iron pipes are somewhat readily corroded; but lead pipes are more easily eaten through by rats or cut by nails, &c. The former are usually 4 or $4\frac{1}{2}$ inches in diameter. They should be coated by Dr. Angus Smith's process, or by the Barff or Bower-Barff process, for the prevention of rust.[1] The thorough joining of such pipes is a matter of some difficulty, requiring careful and skilful plumbing work. The joints of iron pipes are often made inefficient by changes of temperature causing expansion and contraction of the metal and loosening the joint. The junctions should be well caulked and leaded; putty should never be used. Where such a pipe passes down inside a house against a wall, the part of the joint next the wall is difficult of access, and the work is often badly done, sewage gas being permitted to escape directly into the house through the faulty joint. Drain-pipes should be made of glazed earthenware, preferably salt-glazed. Porous earthenware pipes are, on no account, to be used, nor brick-built drains. They are easily broken, and permit leakage into the soil, and

[1] In Dr. Angus Smith's process, the pipes, heated to 700° Fahr., are immersed in a mixture of coal-tar pitch and linseed-oil heated to 300° Fahr., where they are left till they cool to 300° Fahr. Then they are removed and set to cool in a vertical position. In the Barff process, the iron is carefully cleaned, and is exposed, in a chamber kept at a very high temperature, to the action of superheated steam. The steam is decomposed by the heat, and a deposit of black oxide of iron—magnetic oxide—is produced on the pipes, which protects them from rust, the more effectually the greater the heat to which they were exposed, and the length of time they were exposed to the process.

then the hot atmosphere of the house will draw the foul air from the soil, the foundations of the house being also constantly damp.

Mode of Junction of Pipes.—The glazed earthenware drain-pipes should be socketed, so that the end of one section terminates inside the socket or flange of the other. The one pipe should properly fit the other, and the junction should be completed by cement, not mortar or clay. At proper intervals, drain-pipes should be provided with special inlets for inspection and cleaning purposes. Sections of pipe are made with such inspection eyes which pass upward to or near to the surface and are provided with a properly-fitting cover, sealed with mortar or putty. Round these access pipes a manhole may be built provided with a cover, which may be simply a flat stone, with a ring in it, bedded in cement or mortar. It is very necessary to see that drain-pipes are provided with a firm bed. If the soil is a made-up one, in particular, it will readily yield and the pipes may thus become broken or distorted. Where special care is being taken, it is advised to provide a cement bed, along the whole length of the drain to its junction with the sewer, care being taken that at appropriate intervals small cement chambers are built to admit of access for cleaning or inspection. Large-sized pipes should never join smaller ones; and when a junction is being effected between pipes of different sizes it ought to be by means of tapering pipes. The average diameter of drain-pipes is from 4 to 6 inches.

Junctions with drain-pipes should never be effected at right angles; the one pipe ought to pass gradually into the other, so that the current is not interrupted, the entering current having very nearly the same direction as that in the drain that is being entered. For similar reasons sharp turns are to be avoided, with their inevitable slowing of the current and tendency to encourage deposition of sewage matter. Pipes with curves to suit all kinds of turns are now provided, and their use should always be insisted on. Careless and indifferent workmen, to save themselves the trouble of securing such curved pipes, have been too often known to knock a hole in the side of one pipe, through which the end of the connecting pipe is passed, the space being filled up with cement, or not filled up at all.

Drain-pipes should always have a proper fall; the best practice is to allow a fall of 1 inch to each yard.

Position of Pipes.—It is customary for the pipe from the water-closet—the soil-pipe—to pass down inside the house, receiving branches on its way, from closets on different landings, or in the case of tenements, from closets from different houses, and being also joined by the waste from the bath, wash-hand basin &c. It often also receives the waste from kitchen, scullery &c., all the soil and waste from the dwelling indeed passing into the soil-pipe, which ultimately joins the drain at the basement. Now this is a bad system, for if any leakage occurs in any part of its course, if any faulty joint exists, and as already stated the changes of temperature, to which the pipe is subject, are very apt to make the joints leaky in time, the house gets the whole benefit. If there is any defect in fittings connected with the kitchen, scullery &c., the connection of their waste-pipe with the soil-pipe will ensure the entrance of gas into the house. It is, therefore, the first maxim of a sound sanitary system that the soil-pipe is carried out of the house as quickly as possible. It should pass down the back wall of the house. The branch from each closet should pass as directly as possible through the wall to join it, and in this way it can receive as many branches as may be deemed necessary. There ought to be no difficulty, in constructing a house, in placing the water-closet against the wall of the house so that there need be no long branch pipe to connect with the main. If any leak occurs in the course of the pipe, the sewage gas escapes into the open air, where it can do less damage, unless in the event of a window being in the immediate neighbourhood. The soil-pipe should be carried up to the roof, its full diameter, to act as a ventilating pipe. With such an arrangement, the closet basin having a trap beneath it, all fitting being properly made, and the soil-pipe passing outside through a disconnecting trap (Fig. 284), there should be no risk whatever from human excreta. If in addition to closet basins, the house is provided with a urinal, it also would be trapped inside and its discharge pipe would join the soil-pipe. If possible the soil-pipe should not pass near to windows, lest gas from a leaky joint should enter the house by the open window.

All other waste-pipes, pipes from bath, basin, sink, scullery, wash-house &c. should enter a separate pipe, having nowhere any connection with the soil-pipe. It also should pass down outside the house, receiving the various branches on the way, each branch having a separate trap upon it, just underneath the bath, or basin, or sink, as the case may be. This waste-pipe also should be disconnected from the drain by a dis-

connecting trap. If the soil-pipe is trapped at the foot, the waste pipe could terminate in the open air, discharging its water into the same trap through the grating, or the pipe might open into the trap, just beneath the grating, the soil-pipe opening at a lower level. If, however, the ventilating trap on the soil-pipe is at some distance from the house, as is desirable, the best arrangement would be to have a trap for the wastes alone, such as the Hart trap (Fig. 285), into which also rain-water pipes from the roof could discharge, all opening in the air over the grating or immediately under the grating.

Where it is at all possible to avoid it, drain-pipes should never pass under a house. If they leak, the house gets the full advantage either because of the direct escape of sewage gas, or because of effluvia from the soaked soil. The soil-pipe and waste-pipes should always connect with the drains, *outside of the house*, and if it is necessary for the drain to pass from back to front of the house, it should be carried round outside. Where it is unavoidable that the drain pass below the house, the utmost care should be exercised in its laying and jointing. It ought to be laid in cement, and at appropriate intervals access chambers, provided with air-tight covers should be provided, so that whenever necessary the drain could be inspected or cleaned, without unnecessary disturbance. It is not unusual to find a drain altogether outside of a house and yet practically opening into it at the basement, because of a rain-water pipe carried under the floor space to join the drain. As the pipe is only to carry rain-water, probably no great pains have been expended on its junctions, and perhaps it joins the main drain directly, without the intervention of a trap, with the notion of serving as a ventilating pipe for the drain. The result of the whole arrangement is that the warm air of the house sucks sewage gas, direct from the drain, through the defective joints of the pipe, as it passes beneath the basement, and the drain is literally being ventilated into the house.

Common Defects in House Drainage.

Defects in the Soil-pipe.—It has already been noted that it is a serious error to carry the soil-pipe through the interior of the house, if it is at all possible to carry it outside. It is often made to pass through rooms, pantries, larders &c., which ought not to be permitted. It is frequently not ventilated at all, or is ventilated only by a pipe of much smaller diameter than the soil-pipe itself. Sometimes the rain-water pipe is made to serve as a ventilating shaft for the soil-pipe, and it may terminate at the eaves in close proximity to a window, through which its foul air may be discharged into the house. If we summarize defects of workmanship in the kind of pipe used, in the making of joints &c., and the dangers arising because of want of disconnection between the soil-pipe and the main drain, defects already incidentally alluded to in noting the correct methods of arranging for the soil-pipe, there remains yet one frequent source of mischief. The cistern from which the flushing water for the closet is derived is also frequently the same cistern from which water for the domestic purposes of the household is obtained. The cistern is provided with an overflow-pipe, and this pipe is not uncommonly connected with the soil-pipe, so that the soil-pipe may actually be ventilated into the water, which is subsequently used for cooking and drinking purposes. The closet ought to be provided with a cistern for itself, and its overflow-pipe ought to be made to discharge into the open air.

Defects connected with Waste Pipes.—Waste pipes are very frequently made to enter the soil-pipe untrapped, or they join a rain-water pipe, which has a direct connection with the main drain. The rain-water pipe, in such a case, is supposed to act as a means of escape of foul air from the drain, but the arrangement almost ensures the entrance of gases from the drain into the house. Moreover rain-water pipes are quite usually carried down inside a house between the outer wall and the plaster, and if their joints are defective, as they almost always are, not only is foul air drawn into the house, but in the case of storm, when the pipes are running full or may be partially blocked, water also escapes between the walls.

Defects to be looked for in drains are numerous. Improper—porous—material is employed; joints are badly effected; sometimes one pipe is simply shoved into another, no cement being employed; if a piece of rock is being crossed in the bed of the drain, a lazy workman may chip off a piece of the pipe socket to avoid chiselling out a piece of the rock; a hole may have been driven into the pipe for inspection purposes, and subsequently covered only with a slate; the soil may have subsided causing cracking of the drain; or the house may have settled and the drain may have been crushed, for want of a protecting arch where it passed through the wall. In all these ways material may be permitted to soak into the soil, the emanations ultimately reaching the house.

The soil-pipe, drain, and main sewer may be in direct connection with one another, no trap intervening.

What has been said as to the means of preventing drains polluting a dwelling and the usual departures from sound methods is illustrated by the two following figures.

How a House Ought Not to be Drained is illustrated in Plate IX[a], which exhibits a plan of a self-contained house or villa. *Fig. 1* shows the ground-plan and *fig. 3* a section. The reference letters are the same in both. D D D D is the main drain which passes from front to back *underneath the house.* It is partly made of fire-clay pipes, and partly a brick-built drain. It terminates in a cesspool C built of brick, which is provided with a dipstone. The faults of this arrangement are: (1) The drain runs under the house and the house gets the full benefit of any and every leakage that occurs; (2) the earthenware pipes forming the front part of the drain are simply pushed into one another with no properly cemented joints; (3) the curve in front is not effected by curved pipes but by straight pipes, the flow from one pipe to the other will be impeded, and the drain is apt to be blocked; besides, the leakage will be very great; (4) the walls of the drain throughout are porous and leakage into the soil will occur all along, sewage emanations being drawn from the soil into the house owing to its warmth; (5) the cesspool acts simply as a retainer of foul putrefying material, leakage also occurring and being meant to occur from it; (6) the dipstone does not impede the backward passage of foul air, for foul gas is generated on the house side of it as well as on the sewer side, and the dipstone is so placed as to be perfectly useless (see *fig. 3*). The house pipes are thus in direct connection with the sewer; (7) the drain has no proper fall; (8) the drain passes through the foundation walls (at F, *fig. 3*) without any precaution to prevent damage through subsidence.

From the main drain branches pass off to various apartments. Beginning near the cesspool, **the first branch, 1**, is partly a brick-built pipe passing in under the washing-house floor, and ending under a grating (G, *fig. 1*) for the removal of surface water. The pipe from the tubs passes directly into this branch. The faults here are threefold: (1) This branch passes directly into the main drain and thus leads off sewer gas straight into the house; (2) the wash-tubs and surface grating communicate directly with the branch, untrapped, and (3) the mode of junction of the pipe from the tubs with the branch is one which tends to encourage deposit occurring in the branch. The **second branch** from the main drain is a rain-water pipe, 22′ 2″ (*fig. 3*), which passes up the end of the house and has a branch opening under the window W, for running off the rain-water from the roof, R, while it terminates at the eaves at 2″, near the upper part of the same window. The fault here is serious, for this pipe being in direct connection with the main drain acts as a blow-off for foul gas which it discharges beneath and in a line with the top of the window. Any time the window is open sewage gas will gain access to the house from it.

Branch 3 goes to the long hopper closet, a bad form of closet. (See p. 717.) It is faulty besides (1) in that the trap is not ventilated, and (2) the pipe from the w.c. enters the drain in a direction against the current (see *fig. 1*), and thus excreta will always be retained in the pipe.

Branch 4 (shown in *fig. 1*, though not seen in *fig. 3*, because of the position of the section) is the waste-pipe from a bed-room basin. Its faults are (1) its direct connection with the drain causes it to lead off sewage gas into the bed-room; (2) leaky joints make it a more certain conductor of foul air into the house; (3) it is ventilated by a pipe opening into the flue of the bed-room fireplace. In warm weather, when no fire is on, and when the atmosphere of the room is cooler than that of the outside air, there will be a down current of air into the room, and this will carry with it the foul air from the pipe.

Branch 5 leads to a scullery sink. (1) It also is in direct connection with the drain; (2) the only protection against the entrance of foul air from the drain is the leaden trap (*fig. 3*); but it has been pulled out of shape by the workman when the joint was made, and the water no longer stands high enough to act as a seal; (3) the scullery sink is so placed that the servants' back is always to the light; the sink is, therefore, dark.

Branch 6 is the soil-pipe. It is connected (*fig. 3*) with a pan-closet and receives also the waste from the bath (B), while it is continued to the roof to act as a ventilating pipe, and also as a rain-water pipe (6″) for the roof, while it receives the overflow pipe (6′) from the cistern, this pipe being connected merely by a slip-joint. The evils of this arrangement are enormous. (1) The soil-pipe is practically unventilated for no fresh air can enter the main drain to sweep up the pipe; (2) The w.c. is of the worst pattern, the pan w.c. (see p. 717); (3) the bath waste

PLAN AND SECTIONAL ELEVATION OF VILLA.

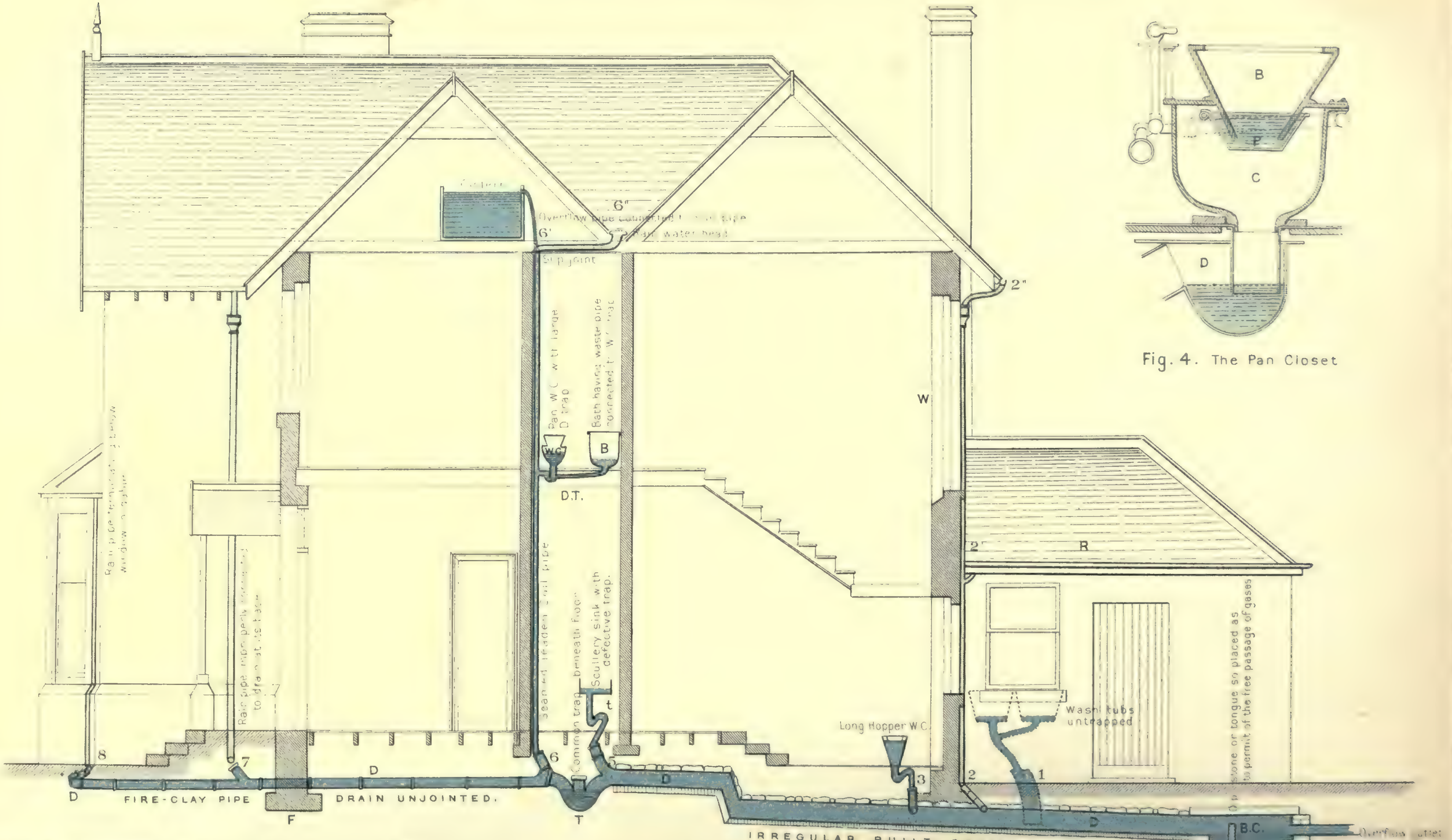


Fig. 2. SECTIONAL ELEVATION ON THE LINE A.B ON PLAN.

Fig. 4. The Pan Closet

Plate IX[a]

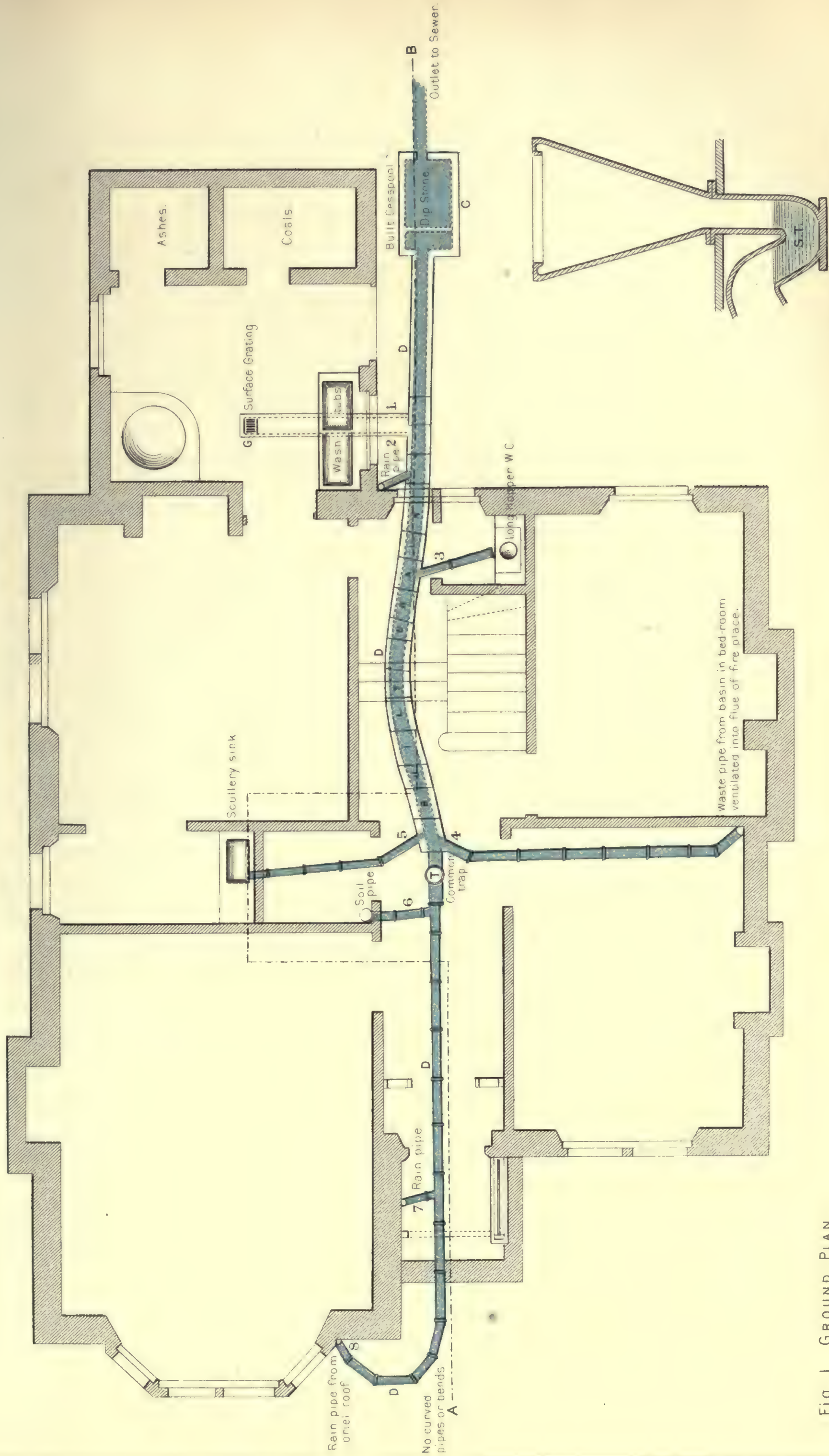


Fig. 1. Ground Plan.

Fig. 3. The Hopper Closet

enters the D trap of the w.c., which is certain always to be foul, and thus the waste-pipe simply leads off the foul air of the trap into the apartment; (4) it is a great mistake for the continuation of the soil-pipe to be made a rain-pipe, the risks of blocking being serious; (5) the water of the cistern is certain to be polluted by gas escaping up the overflow pipe, which also secures that the soil-pipe shall be ventilated, not into the open air but into the air of the house.

The trap T is an excellent illustration of the foolish way in which traps are sometimes employed. It is placed under the house floor, so that it is impossible to make it a ventilating trap. It simply acts as a detainer of the excreta coming down the soil-pipe, so that instead of that material being swept out of the house as quickly as possible it is detained for a longer or shorter period in the trap, and it prevents the possibility of any current of fresh air passing through the drain.

Branch 7 is for a rain-water pipe, but the pipe falls short of the entrance to the drain, and a constant soakage of the soil occurs from water missing the drain, while sewage gas pours into the soil from the open drain.

Branch 8 is a rain-water pipe, defective because (1) of its direct connection with the drain, and (2) because it terminates below a window in the gable.

How a House Ought to be Drained is illustrated in Plate IX^b. The upper figure shows the ground-plan, the lower a section. It represents the same villa as Plate IX^a. The chief features of the system there shown are these: I. The drains are all outside the house, and all house pipes are carried outside the walls as speedily as possible; II. there is no pipe for the removal of waste water in direct connection with any drain; III. the soil-pipe is kept entirely separate from the rain and waste pipes, the two systems being disconnected from one another by means of ventilating traps.

Let us study these figures to understand how these things are managed. We shall begin with the outfall to the main sewer O, which is a 6-inch glazed earthenware pipe, with joints caulked and cemented. The first thing to notice is the ventilating trap (V T^1), a 6-inch trap of the Buchan type (Fig. 284). This trap at once disconnects the whole of the house drainage from the common sewer. Entering that trap there are two drains, S D^1 and S D^2.

S D^1 is a glazed earthenware pipe drain, 6 inches in diameter, joints being caulked and cemented. Communicating with it are three different house-pipes, namely the soil-pipe from the upstairs w.c., the waste-pipe from the scullery sink, and the rain-water pipe, carrying off the rain-water from the roof and receiving also the waste water from the bath. These arrangements are shown in dotted lines in *fig. 3;* in dotted lines because a section such as is represented in the figure would not actually display them.

Taking the soil-pipe first, observe (1) that it passes right up to open above the roof, tapering out as it opens (S P, *fig. 3*); (2) that the w.c. is trapped (T) before it enters the soil-pipe, and that the trap has a pipe (V) passing off its highest outer point into the soil-pipe so that the air current through the soil-pipe prevents any accumulation of gas on the soil-pipe side of the trapping water; (3) that no waste or rain pipe enters the soil-pipe; (4) that the w.c. is of the Bramah type; and (5) that the w.c. has a special cistern (C^2) for flushing water, and has no connection with the cistern (C^1) supplying the house with water for domestic purposes. Observe lastly that the soil-pipe is continuous with a drain which has no direct connection with any other house-pipe, all waste or rain-water pipes in communication being cut off from direct connection by ventilating traps. It should be noted that apart from the trap connected with the w.c. there is no trap whatever on the soil-pipe or the drain it joins, till we reach the disconnecting trap V T^1. The result is that air entering the inlet grating of V T^1 (see *fig. 1*) passes right up the drain S D^1, and escapes at the top of the soil-pipe above the roof, so that there is a constant current of fresh air through the drain and soil-pipe. This is a preferable arrangement to having a ventilating trap on the soil-drain, at the point marked **X**, for example, near to some of the house windows, provided the length of drain before the ventilating trap V T^1 is reached be not too great. If, however, this distance were great, say more than 30 feet, a ventilating trap might be interposed sooner, provided it were out of the way of windows. Next let the scullery arrangements be noticed. The sink (S) is brought over to the window space (*fig. 1*). Its waste-pipe W P is trapped, and opens outside immediately under the grating of a grease-box (G B, *figs. 1 and 3*), the outflow from which joins the soil-drain.

Thirdly, the rain-pipe from the roof, R P, is disconnected from the drain by a Hart trap, H T (see Fig. 285). This rain-water pipe receives the waste from the bath B, the waste-pipe being

trapped (T) before it enters the rain-water pipe (see *fig. 3*).

Returning to the ventilating trap, $V T^1$, let us follow the drain, $S D^2$. It is a 4-inch glazed earthenware pipe. (1) It passes straight into the servants' w.c., which is a wash-out closet, and (2) it is continued, outside the house ($S P^2$, *fig. 3*), right up to open above the roof as did the other; (3) the pipe from the w.c. is trapped, and the trap has a ventilating pipe, T, leading into the soil-pipe. This closet is also supplied with a separate cistern.

This drain ($S D^2$) receives two main branches, one opening on the right, the other on the left (*fig. 1*). A very short way on, however, each of these branches is cut off from direct communication with the soil-pipe drain by a ventilating trap, $V T^2$ and $V T^3$. The right branch has two divisions, one (1) is a pipe removing waste water from the washing-house tubs and washing-house floor, and the other (2) carrying rain-water from the washing-house roof. The waste from the tubs is, however, trapped just under the tubs (see *fig. 3*), and the pipe running off the water from the floor communicates with the floor through a syphon trap (S T, *fig. 1*). Moreover, the trap of the tubs is supplied with a $1\frac{1}{2}$-inch ventilating pipe carried to the roof. The rain-water pipe has no trap apart from the ventilating trap $V T^2$, and thus a free current of air from the inlet grating of that trap is allowed right up the rain-water pipe.

The branch, R D, to the left (*fig. 1*) is cut off from the soil-pipe drain, $S D^2$, by the ventilating trap $V T^3$. It receives two rain-pipes from the roof $R P^1$, $R P^2$, which are not trapped at their base, and it also receives a waste-pipe, W P. This is the waste-pipe carrying off the waste from the bed-room basin, which in Plate IX^a is shown as branch 4 and was ventilated into the bed-room flue. It is in Plate IX^b continued to the roof as a rain-water pipe. In the bed-room the waste would be trapped under the basin, and from the trap a ventilating pipe would be carried to join the upward continuation of the pipe. For additional security this combined waste and rain pipe opens at its base into a Hart trap (H T) (*fig. 1*, Plate IX^b).

To this description of the two plates one need only further add that the soil-pipes, in the properly constructed drainage system, are all heavy cast-iron pipes, with caulked and leaded joints, that the inside traps are made of drawn lead, the pipes ventilating the traps are drawn lead pipes, $1\frac{1}{2}$ inch in diameter, any junctions being effected by means of wiped joints. The drains, as already noted, are all of glazed earthenware with joints properly cemented.

Plate IX^a shows also the space for coals and ashes opening into the washing-house, and thus in free communication with the air of the house. Plate IX^b shows this remedied by the communication with the house being built up, and direct openings to the outside being substituted.

Testing Drains.—There are several methods adopted for determining the soundness of a drainage system. One of these methods consists in pouring oil of peppermint, or other volatile strong-smelling substance, mixed with hot water, down the soil-pipe from its opening above the roof, and searching in and outside the house for any place where the smell of the oil indicates a fault. Sulphur may be burned on the house side of the disconnecting trap; and if any escape into the house, its presence will be detected by the smell, and the existence and position of the leakage will be thus indicated. The common method in use is the smoke test. Oily waste, sometimes sprinkled with sulphur, is burned in a covered box communicating with the drain, or if the system is trapped, with the house side of the trap. By means of a fan turned by a handle, or a small bellows fitted to the apparatus, air is driven into the box and the smoke driven into the pipes. If any leak exists the smoke will readily gain access to the house and be detected by the smell. When the pipes are filled with the smoke so that it issues from the openings above the roof, these are usually blocked, and the air continues to be forced into the pipes. Smoke is in the pipes at pressure and a leak is readily detected. The doors and windows of the house should be kept closed, to confine any escaping fumes to the apartment into which they enter, so that the locality of the leak may be more readily found. Another method consists in blocking the drain at some point outside of the house or at the outflow end of the trap, and running water into the pipes from sinks, baths, closets &c. till the pipes are full. The pipes should remain full, but if they leak the level of the water will fall, and the amount of leakage may be estimated by the water it is needful to keep running to maintain the level. The appearance of wetness in walls &c. will indicate where the leakage is occurring.

Flushing of Drains.—To keep drain-pipes as clean and free as possible from deposit, frequent flushing with water is needful. The larger the body of water with which this is done the better. A constant dribble of water is not nearly so effective as an occasional rush of a large quantity.

In all houses there is a continual flow of waste water from wash-hand basins, baths, rain-water pipes &c. which is not very effective for cleansing purposes, as it ordinarily is allowed to escape, but which if collected and allowed periodically to escape in a body into the pipes would flush them very thoroughly. Such water might be collected in a tank in connection with the drains and might be supplied with a self-acting arrangement, which, when the tank was full, would cause the water to be discharged into the pipes till the tank was empty, when the communication would be closed till the tank was again full. A considerable number of tanks have been patented for this purpose, of which Field's is one of the best known. It

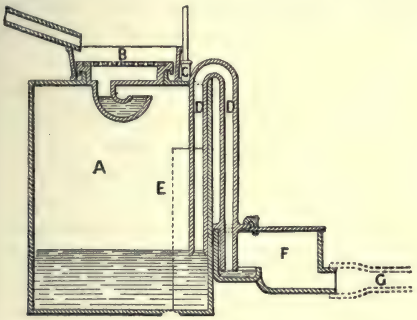


Fig. 292.—Field's Flushing Tank.

A, Tank. B, Trapped inlet. C, Ventilating pipe. D D, Syphon. E, Strainer for grease &c. F, Discharging trough. G, Outlet to drain.

is illustrated in Fig. 292. It is a tank fixed underground, the feed of which may be supplied with rain-water, or bath waste, or by means of a tap direct from the main. Towards one end is fitted a syphon arrangement, DD, one limb of which is long and opens below into water of the trap, F. This limb rises to the height of the top of the tank and then bends over, passing down into the tank to open not far from the bottom. As the inflowing water rises in the tank, it also rises in the inner limb of the syphon till, when the tank is full, it reaches the bend at the top, over which it passes. The syphon action is thus automatically started and the water continues to flow out by the syphon till the water in the tank is brought down to the level of the opening of the inner tube. The tank is in short rapidly almost emptied, and the body of escaping water effectually flushes the drain. As soon as the water in the tank falls below the level of the opening of the inner tube, air enters, and the syphon action stops. The tank again begins to fill and the water continues to rise, till the syphon is again set in action by the water reaching the level of the bend of the syphon. Beyond the trap the outflow pipe enters the drain, G, and the trap prevents the backward passage of sewage gas into the tank.

It is now necessary to make a few references to some of the interior arrangements for the disposal of waste.

The Water-closet first of all demands our attention. The old form of water-closet, now universally condemned but still to be found in houses, is shown in Plate IX^a, *fig. 4*. It is placed here as a useful example of defects to be avoided. It is called the **Pan Closet**. The basin, B, is the part visible, the other portions being concealed beneath the seat. At the outlet of the basin is the pan, P, lowered by raising the handle, by which means also the inflow of water is occasioned from the cistern above, which washes out the soil. The basin opens into the container C, and that opens, by the pipe shown, into the D trap, which again leads into the soil-pipe. Now the inside of the container, as is evident from the figure, will be continually coated with excrement splashed up upon it, which no amount of flushing can remove. The D trap is also certain to be constantly foul from the same cause. Thus the trap and container are always full of foul air, delivered into the house every time the handle is pulled up. It is the shape of the closet which makes it bad. It does not matter of what material it is made, it is not possible to keep it clean.

The chief thing to be desired then in a water-closet is a form which, by its very shape, guarantees the effectual scouring off from every part of it of every particle of adherent excrement. The pipe leading from the tray or safe for carrying away any water that may overflow is usually made to open into the trapping water, and thus it ventilates the trap into the house. It has been found opening directly into the soil-pipe, and thus leading off foul gases from the soil-pipe into the house. It ought however to be taken through the wall to the outside, being provided with a flap-valve to prevent entrance of cold air.

The **Hopper Closet** shown in Plate IX^a, *fig. 2*, is another form condemned for a similar reason: it does not admit of the flushing water cleansing every portion of its interior, and a great deal of material is likely to be retained in the syphon-trap shown below S T.

Wash-out Closets.—There are now in the market many forms of water-closets which avoid the defects which have been noted. They are commonly made of some kind of earthen-

ware, the basin and the trap beneath being all in one piece. *Fig. 2* of Plate IX^b, shows one of these kinds where T is the trap, S leads into the soil-pipe, and V is a ventilating-pipe. By means of this pipe if the soil-pipe communicates with a disconnecting trap, and the soil-pipe is open to the roof there is a guarantee of a constant current of fresh air preventing any accumulation of foul air in the trap.

The **Valve Closet** or **Bramah Closet** shown in Plate IX^b, *fig. 4*, is one which meets with commendation. The figure also illustrates how it ought to be connected with the trap T. The safe placed on the floor to receive any water which escapes over the basin, should be provided with a waste-pipe, passing directly outwards and opening in the outer air. The external opening ought to be provided with a flapper to prevent the inrush of cold air.

Flushing Water.—A good form of closet being secured and properly set up, the next thing is to see that a full supply of flushing water is provided. This depends upon the size of the service-pipe. The supply ought to be sufficient to fill the overflow-pipe O (*fig. 4*, Plate IX^b) every time the handle is drawn.

The Connection of Water-closet and Cistern demands attention. The cistern is certainly provided with an overflow-pipe, and the important question is where does that overflow-pipe go to. It is probable that it enters the soil-pipe, or the water-closet trap, or passes directly to the drain itself. In such an event the waste-pipe is simply tapping the foul air of the drain, trap, or soil pipe, and conducting it into the house. It may connect with the waste-pipe of the bath, wash-hand basin or scullery sink; and to all of these connections there is the same objection. In cases where the house is not supplied with water for domestic purposes direct from the main, but where the same cistern supplies the water to be used for cooking and drinking purposes, the evil is a double one, for the water is being contaminated by the sewer gas, and the household is not only breathing a polluted atmosphere but is drinking polluted water. The waste-pipe ought in all cases to pass to the outside and open in the open air. No cistern supplying water for domestic purposes should be connected with any water-closet, or other arrangement for the removal of excreta. Where the water supply is provided from a cistern, the closet ought to be supplied by a separate cistern, which, if it must be supplied from the main cistern, may be by a disconnecting method which shall guard against any contamination of the drinking water.

Fig. 293.—Arrangement of Waste-pipe from Scullery Sinks.

Sinks.—The sink requiring special attention to be paid to it is the scullery or kitchen sink, for into it there passes a large quantity of greasy material, which readily adheres to the inside of the pipes, to the sides of the traps, and to the walls of the drain, and which in large establishments will clog up the drains sooner or later. For such large establishments a grease-trap is necessary, a trap fixed outside the house, into which the pipe from the sink enters, and of which the outlet-pipe to the drain is so arranged that the grease is retained and collected for periodic removal. Concerning grease-traps Eassie says they are required, "never in cottages, seldom in small houses, sometimes in the larger dwellings and villas, where cook and scullery-maid reign below stairs, and always in houses where the number of servants outnumbers the family. This is a very skeleton definition, but it is all my space will allow. Where a grease-collection trap is necessary, unless that accommodation be rendered, the underground drains will choke up, and necessitate their being opened up and cleaned out. The need for a grease chamber is enhanced when the culinary utensils are scoured out with sand at the scullery sink, and if a chamber be not provided, the drain will clog all the sooner, as the sand does not get to the sewer, but becomes embedded in the grease." Where a grease-collection trap is not necessary, it is needful only to recal what has been already said on p. 713, that the sink waste-pipe should not open into the soil-pipe but have a separate house-pipe,

PLAN AND SECTIONAL ELEVATION OF VILLA.

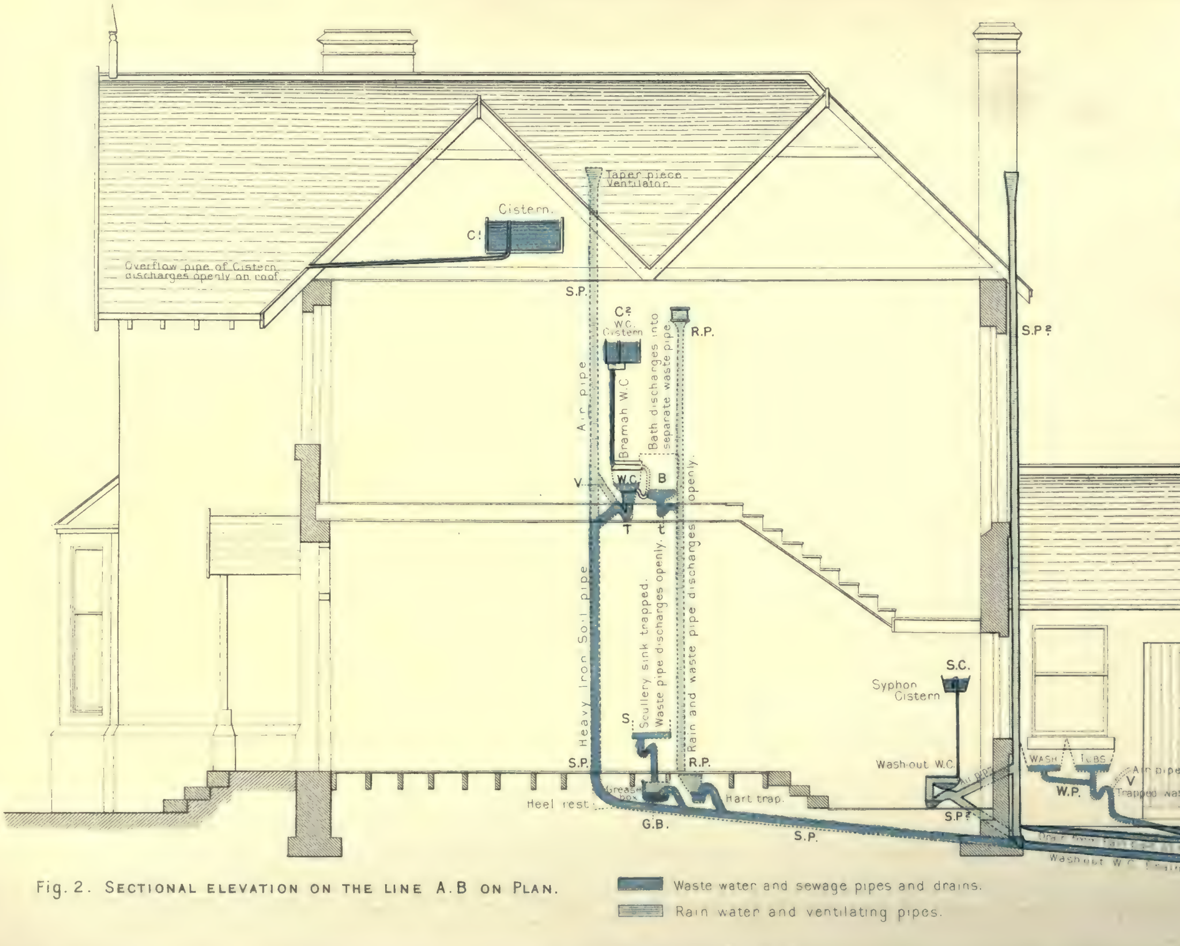


Fig. 2. SECTIONAL ELEVATION ON THE LINE A.B ON PLAN.

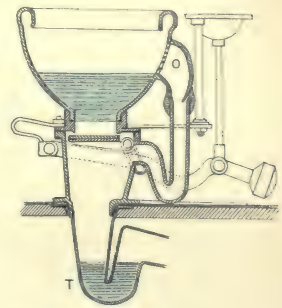


Fig. 4. Bramah Closet.

Plate IX[b]

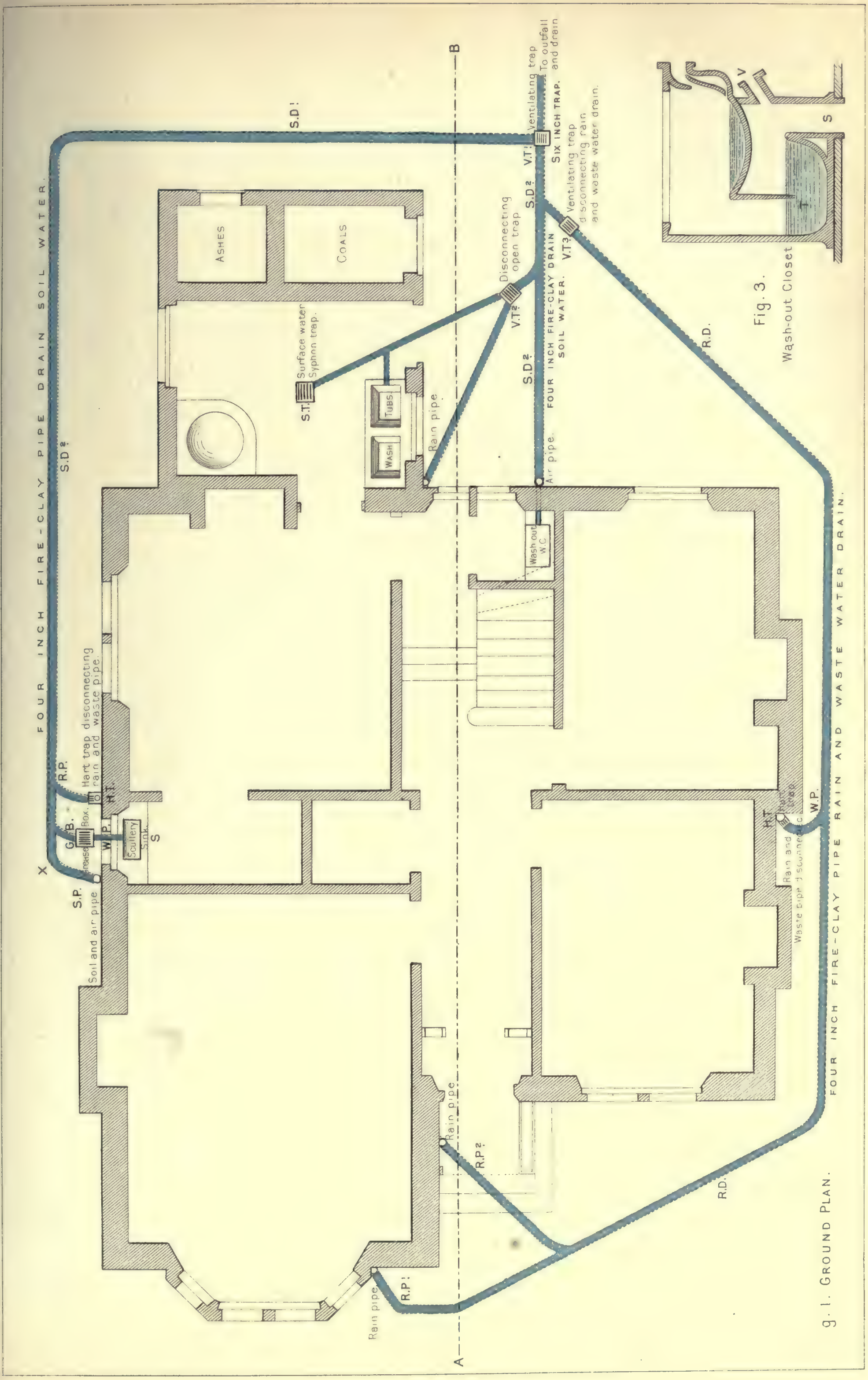


Fig. 3.
Wash-out Closet

g. 1. Ground Plan.

that that pipe should open in the open air either over or immediately under the grating of a disconnecting trap, preferably of the gully form, by which any sand and other solid waste may be intercepted, lest its entrance into the drains obstruct them. Such an arrangement is shown in Fig. 293.

Bath and wash-hand basin wastes are similarly treated, and all are trapped within the house by the syphon trap (s) shown in Fig. 293. The form of syphon for sinks connected with kitchen, scullery, wash-house, &c. ought to be the access-syphon, illustrated in Fig. 294. The screw in the bottom of the trap permits of opening the trap for the removal of any retained solids which cannot be washed away readily.

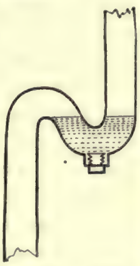


Fig. 294.—Access-syphon.

Grease Traps are shown in Figs. 295 and 296. Owing to the depth of the lip of the trap, the layer of floating grease is prevented passing into the drain, and can be removed at intervals.

It has been questioned whether, provided the sink waste is provided with a system separate from the soil-pipe, and is properly disconnected from the drains, as shown in Fig. 293, any trap immediately under the sink is advisable, and whether it is not rather objectionable from its risk of retaining decomposing materials, grease, soap-suds, and the like. If the waste-pipe were to pass directly through the wall and were very short, no such trap might be needed, but it is needed where the sink is any distance from the place where the waste-pipe opens, and where the waste-pipe is consequently of some length. For the grease, soap &c. retained in the pipes, occasion very objectionable smells, which would be drawn into the house by its warmth. Where the pipes are of some length, indeed, not only is the trap desirable, but it is also advised that a ventilating pipe be led off from the outer side of the trap and be carried to the roof, so that a draught of fresh air is passed through the pipe to keep the air sweet.

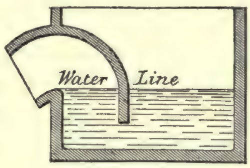


Fig. 295.—Grease-box.

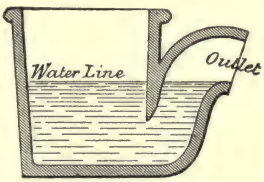


Fig. 296.—Grease-box.

Drainage and Water-supply.—Where the water is supplied from mains there is little risk of pollution from drainage. Care ought, however, to be taken that the service-pipes are not in proximity to the drains, and hot-water pipes ought not to pass through the house alongside of cold service-pipes, causing the heating of the cold water. Attention ought to be given to the position of the cistern provided in connection with boilers for heating water for domestic purposes. Such cisterns are usually placed in out-of-the-way corners, covered in and never examined as to their cleanness. It is too common, according to Eassie, to find it placed in the darkest corner of the commonest stowaway cupboard, with its overflow pipe connected with the drain. "On one occasion," he says, "in a large town house in the west of London, the servants complained that the hot water drawn from the tap at the kitchen jamb tasted badly, and was of the colour of weak tea, which was no wonder, for an exploration of the feed cistern in the cupboard led to the removal of several basins full of drowned black beetles, in all stages of dismemberment."

Whenever the water-supply is obtained from wells, great precaution must be taken that the water is not contaminated by sewage before it reaches the house. Collections of dust, refuse, and rubbish of various kinds in the neighbourhood of the well are certain to lead to its pollution. For the water from the heap percolates into the soil and in due time reaches the water. Cesspools near the well are specially to be guarded against. Leaky joints in the drains, which permit the escape of sewage, are also a frequent cause of contamination. If any of the drain-pipes, instead of being of glazed earthenware, are made of porous material, leakage into the soil occurs, and the water-supply of the well will get a full share.

Cisterns.—The water-supply of the house, when derived from a well or a stream, may be pumped up into a cistern in the house, or led thither by gravitation if the source be higher than the house. In such an event the cistern exposes the water to pollution, supposing it may have escaped previous contamination. Cisterns of sawn slate are to be preferred. Those of stone or brickwork cemented inside are also cleanly and useful. Galvanized-iron cisterns are unobjectionable. Wooden cisterns lined with lead are common. The risk of contamination of the water with lead has been spoken of on p. 642. An insoluble salt of lead is soon formed which coats the metal and pre-

vents any such poisoning of the water. This should never be scraped off. When the cistern is cleaned, and every kind should be periodically cleaned, at least once a year, a scrub with a hard brush is all that is necessary. Cisterns of wood only should never be employed, because of their certainty to decay and because they afford material for the growth of low forms of vegetable life. Zinc-lined cisterns are also objectionable. When the cistern is lined with lead, if the water has been retained in it for any time unused, through the house being shut up for example, the standing water should be run off and a fresh supply allowed to enter. Indeed in every case this should be done.

Cisterns should never be inside the roof space of a house, but whenever possible in the open air. They ought to be covered but also ventilated. The trouble of cisterns outside is their liability to frost. This may be greatly diminished by a proper lining of wood, or by a surrounding space filled with saw-dust, or by a lining of inodorous felt. The overflow-pipe should open directly into the open air.

Dry Methods of Removing Excreta.

It is often not possible to remove excreta from dwellings and towns by water carriage, either because the water is not at hand, or because there is not sufficient fall for a due outflow or for other reasons. Even where water carriage is possible the pollution of streams and rivers, which it usually involves, makes it desirable to find other means. Various other methods of removal have therefore been suggested and adopted. The refuse solid and liquid may be received in tanks and boxes and these may be daily removed and their contents applied as manure to land. The land must be at some distance from dwellings, however, and in the case of large towns the expense of collection and cartage becomes great.

The Dry System of removal consists in mixing the excrement with dry earth, ashes, or other material, which absorbs moisture, delays putrefaction, and prevents smell. The mixture is then applied as manure to land. It is necessary in this system that slop water, waste water from sinks &c. be excluded and removed in some other way. For schools, country houses, villages and small towns, it is a convenient and desirable method, under certain conditions. These are that sufficient of the mixing material be provided, in a perfectly dry state, to cover up the excrement and absorb the watery portions, that the mixture is frequently and regularly removed, that the closet is in a position as separate from the dwelling as possible, and that it as well as the place for the pan, pail or other receptacle is properly ventilated.

Moule's System is the proposal of the Rev. Henry Moule, by which dry earth is mixed with the excreta. The absorbing power of dry earth is very great, and the mixture is quite inoffensive. The apparatus required for this system consists of a pail to receive the excreta, and of a hopper which holds the dry earth. The arrangement is such that when the handle of the closet is pulled a proper quantity of earth is thrown into the pail.

Charcoal or various deodorizing substances may be substituted for the dry earth. The earth after removal may be prepared for use again by allowing the organic matter to become destroyed by putrefaction and driving off the moisture by heat. Fine dry cinders may also be employed.

In **Morrell's Arrangement** cinders are thrown upon an opening leading to a sieve placed in connection with a closet. The fine ashes pass through the sieve and are retained till by a movement of the seat of the closet a quantity is thrown upon the soil, the larger ashes pass over the sieve to a pail placed below.

The **Goux System** provides a tub "say 16½ inches high and 20 inches at its greatest diameter. Upon the bottom of the tub are placed 3 or 4 inches of refuse, such as new stable-litter, loft sweepings, stack bottoms, ferns, shavings, saw-dust, shoddy, flax-dressings, spent tan, or hops, or the various waste materials to be found in the town or country. This is mixed with a little soot, charcoal, gypsum, or other deodorizer, for the purpose of lining or packing the tub. A mould of the same shape as the tub, but six inches less than the internal diameter, is placed upon the four inches of absorbent material referred to, and the space between the mould and the tub is packed with the same kind of refuse. One boy can pack eighty tubs in an hour, and this is all the manipulation required, except in placing and removing the tubs at stated times. The absorbent material having been only moderately pressed down, the mould is withdrawn and there remains a cavity into which the dejections fall, the liquid parts of which are taken up by the absorbents, and retained by them so as to check fermentation."

Such dry methods are only applicable on a limited scale, the preparation, storage, and transport of dry earth or other material, and

the removal of the excreta, involving in large towns enormous labour and expense, while it does not do away with the need of some water-carrying system for the removal of slop and waste water.

Sanitary Maxims.

In concluding our considerations of house-drainage, we may put the most important points to be attended to in brief space, in the following maxims selected from Mr. Pridgin Teale:—

1. It is the duty of every householder to ascertain for himself whether his own house be free or not from well-known dangers to health.

2. As a rule the soundness of the sanitary arrangements of a house is taken for granted and never questioned until drain-begotten illness has broken out. In other words we employ illness and death as our drain-detectives.

3. Whenever gas from sewers or the emanations from a leaking drain, a cesspool, or a fouled well, make their way into a house, the inmates are in imminent danger of an outbreak of typhoid fever, diphtheria, or other febrile ailments, classed together under the term zymotic, not to speak of minor illness and depressed vitality, the connection of which with sewer gas is now fully established. Sewer gas enters a house most rapidly at night, when outer doors and windows are shut, and is then perhaps most potent, in contaminating the meat, the milk, and the drinking water, and in poisoning the inmates.

4. The more perfect the public sewers of a town the greater the danger to every house, connected with such sewers, if the internal drain-pipes of the house be unsound, and not disconnected. In houses so misconnected *sewer air is laid on* as certainly for the detriment of health as coal-gas for illumination.

5. A house in which children and servants are often ailing with sore throat, headache or diarrhœa is probably wrong in its drainage.

6. Scamped drain work is one of the most dangerous of the sanitary flaws of new buildings; it is also one of the most common, and one of the most difficult to detect, and is rarely found out except by the illness it produces.

7. If you are about to buy or to rent a house, be it new or be it old, take care, before you complete your bargain, to ascertain the soundness of the sanitary arrangements with no less care and anxiety than you would exercise in testing the soundness of a horse before you purchase it.

8. If you are building a house, or can achieve it in an old one, let no drain be under any part of your house; disconnect all waste-pipes and overflow-pipes from the drains, and place the soil-pipe of the w.c. outside the house and ventilate it.

9. If there is a smell of drains in your house, or a damp place in a wall near which a waste-pipe or a soil-pipe runs, or a damp place in the cellar or kitchen floor, near a drain or a tank, let no time be lost in laying bare the pipes, or drains, until the cause can be detected.

10. If a rat appears through the floor of your kitchen or cellar, and a strong current of air blows from the rat-hole, when chimneys are acting and the windows and doors of the house are shut, feel sure that something is wrong with a drain.

11. If you are tenants and your landlord refuses to remedy the evil, do it at your own cost rather than allow your family to be ill.

12. Many a man who would be aghast at the idea of putting small quantities of arsenic into every sack of flour, and so by degrees killing himself and family, does not hesitate to allow sewer gas to poison the inmates of his house, even in the face of the strongest remonstrances of his medical adviser.

13. A landlord may reasonably look for interest on the money which he spends for the benefit of his tenant; but he is committing little short of manslaughter if, by refusing to rectify sanitary defects in his property, he saves his own pocket at the expense of the health and lives of his tenants.

14. If you be a landlord, don't intimidate your tenants, or threaten to give them notice to quit, if they complain of defective drainage, or sewer gas in the house.

To these we may add a final one:

15. Never use for domestic purposes water derived from a well situated in a street of town or village, or in proximity to dwellings. Be suspicious of water derived from any well in the immediate neighbourhood of a house or farm steading. However excellent it may appear, the risk of its being contaminated is very great.

SECTION V.—CLOTHING AND BATHING.

Clothing.

The Purpose of Clothing:
The Means by which the Temperature of the Body is normally maintained—Regulation of Temperature by the Skin.

The Qualities of Suitable Clothing:
Clothing as a Conductor of Heat;
The Absorption of Moisture by Clothing;
The Porosity of Clothing;
Practical conclusions regarding Material for Clothing;
Inflammability of Clothing;
Form and Shape of Clothing.

Underclothing.
Night Garments.
Dress for Women and Children.
Dress for Men.
Covering for the Head—*Hats.*
Covering for the Feet—*Boots, Shoes and Stockings.*
Poisonous Dyes in Clothing.

Bathing.

The Uses of the Bath:
The Bath for Cleansing Purposes—Soap.
Other Effects of the Bath.

Varieties of Baths:
The Temperature of Various Baths;
The Cold Bath—The Wet Sponge—Wet Towel—Wet Sheet;
The Tepid, Warm, and Hot Bath;
The Hot-air Bath—The Turkish Bath;
The Vapour Bath—The Russian Bath;
Sea and River Bathing—Salt Baths;
Medicated Baths—Alkaline, Sulphur, Pine, Mustard, and Mud Baths;
The Douche, Sitz and Needle Baths.

The Uses of Baths in Disease.

CLOTHING.

The Purpose of Clothing is to aid in maintaining the temperature of the body at the proper, or normal level, that of 98°·4 Fahrenheit. It is not only that clothing is used as a protection against external cold, but it is employed also as a protection against external heat. It is evident that clothing must possess different qualities, according to the kind used, to enable it to fulfil these opposite conditions. Furthermore, we have said the purpose of clothing is *to aid* in maintaining the temperature of the body. Many people are too apt to consider that the heat of the body is maintained by clothing alone, and so they multiply wraps and coverings, regardless altogether of the material employed, and desirous only of interposing a thick enough layer between the surface of the skin and the cold atmosphere. When we say *to aid*, what is implied is that the body itself has the power of maintaining a normal degree of heat, which in some circumstances would be quite sufficient without any covering, but that when the variations of the external temperature are greater than the body can conveniently adapt itself to, some covering becomes a necessity. If clothing is then really to *aid*, regard must be had to the natural means by which the body endeavours to protect itself, so that the natural processes of the body may not be disregarded, abolished or subverted. By what means does the body maintain for itself a normal temperature? is naturally the first question. Heat is produced within the body, and heat is lost from the body. When the heat produced is equalled by the heat lost, the warmth of the body remains at the same level—there is a balance of heat production and heat loss. By the action of the nervous system, which it is unnecessary to consider in detail, the production of heat within the body may be increased or the loss of heat may be diminished to meet increased external cold, or the reverse may occur

to meet increased external heat. The chief means of heat production in the body is chemical combination, the combination of carbon and hydrogen of the food with oxygen, contained partly in the food and also introduced by the air of respiration (p. 532). If none of the heat so produced were given off from the body, it has been calculated that in 24 hours the temperature of the body would be raised to the boiling point. Of the energy produced by this chemical combination $\frac{4}{5}$ths or thereby are given off from the body actually as heat, while $\frac{1}{5}$th is converted into mechanical work. The loss of heat from the body takes place from the skin, from the lungs, in heating the cold air taken in by respiration, and some is removed from the body by the excreta from the kidneys and bowels. Fully three-fourths (77·5 per cent) of the total heat lost from the body are given off by the skin, nearly 20 per cent (19·9 per cent) is given off with the expired air, and a small percentage (2·6 per cent) is lost with the excreta. It is with the skin chiefly that we have to calculate in considering how the body parts with its heat.

The skin loses heat in four ways (1) by radiation, (2) by convection, (3) by conduction, and (4) by evaporation. The meaning of radiation, conduction, and convection has been incidentally explained on p. 699. Radiation doubtless is affected by the clothing worn, rough clothing radiating more rapidly than smooth. A single illustration will suffice to indicate how heat is lost by radiation. Suppose we sit with our back towards a damp cold wall, but not touching the wall, radiation takes place from the body to the wall, and may take place so rapidly that we speedily experience a sensation of chilling, which is commonly attributed to draught, so that it is quite usual to hear some one say, "there is a very cold draught along that wall," while it is simply that the body is rapidly parting with its heat to the wall by radiation. We have all practical experience also of the meaning of convection and conduction. We know that when we sit in still air, its coldness or its heat is not so perceptible to us, as when the air is in movement. Air is a bad conductor of heat, and, while the air is still, the body parts with its heat slowly, for the heat is but slowly conducted through the motionless air; but if a current of cool air play upon a part of the body we are speedily aware of its influence. The particles of air come in contact with the body, become warm and pass off, to be succeeded by other particles, each getting its share of heat so that the body is being quickly robbed of its heat by the myriads of air particles carrying off each one its share. It is, however, by evaporation of sweat that the skin parts with heat most rapidly, and by a variation of the amount of evaporation that the loss is regulated to suit circumstances (see p. 309). Now these facts must be kept in view if one is to appreciate fully the best means by which clothing will fulfil the purpose it is expected to serve, since clothing can be considered to be suitable only so long as it properly reinforces the natural bodily means of regulating the temperature. This will be most easily understood by illustrating how clothing ought to be made to aid the maintenance of an equable bodily temperature (1) in winter or in a cold atmosphere, and (2) in summer or in a warm atmosphere. We may say that in winter there is an increased heat production because of an increased quantity of food consumed, and food of a more heat-giving character, and that in summer there is a lessened heat production because of less food consumed or food of a less energy-yielding kind. Setting this aside, however, we may consider only the variations in the loss of heat.

In **Winter**, or whenever it is exposed to a cold atmosphere, the body adjusts itself to the altered external temperature by a diminished flow of blood to the skin and, in consequence, a diminished loss by evaporation. It is merely a diminution of the loss, not an arrest of loss. Evaporation still goes on but to a diminished extent. Suitable clothing, then, will aid this process by interposing a barrier to the conducting away of heat from the body, or, to look at it from the other point of view, interposing a barrier to the conducting inwards to the body of the external cold, and this it must do *while not interfering with a healthy amount of evaporation from the surface of the body.* For suppose clothing is put on of a kind or in such quantity as to prevent the insensible perspiration (p. 309) duly passing off, what happens? The vapour becomes condensed and remains upon the surface of the body as moisture. The body becomes enveloped by a fine film of water. Now water is a better conductor of heat than air, and thus the condensed vapour is a direct aid to more rapid cooling of the body than is natural, exactly the reverse of what one desires under these circumstances. This is the explanation of the ready chilling of the body after copious perspiration. The sweat has formed more quickly than it can be removed as vapour; it condenses and forms a watery layer which

facilitates the conduction of heat from the body. Many people heap clothes upon themselves and their children in cold weather, not only when going out of doors but also when indoors, and wonder why, in spite of all their wraps and precautions, they and their children feel and are so much subject to the cold. It is just because of their precautions that the tendency to cold manifests itself. Instead of aiding and abetting the healthy action of the skin, they interfere with and subvert it, creating the conditions for a too free perspiration, which, condensing as moisture on the skin, leads to a too rapid parting of heat from the body.

In **Summer**, or in a hot atmosphere, the warmth of the body would maintain its equilibrium mainly by a free but regular evaporation from the surface. Clothing should not interfere with this, and, therefore, ought to be of material which permits free passage to the vapour from the skin. But the clothing ought also to render service by being a non-conductor, so that the external heat may not be communicated to the body. It might be thought that in hot weather, the body should be clothed with material that is a good conductor of heat to enable the body to part more quickly with its heat. But if the external air be warmer than the body, the clothing that is a good conductor will rather conduct heat to the body than away from it. Even supposing the external air be slightly less than the temperature of the body and that, therefore, the clothing would conduct in the proper direction, conduction is not the method by which the body naturally parts with its heat to any great extent, and it is a method which does not act so uniformly, and regularly as that by evaporation. When conduction operates to any great extent, that is when the conduction is effected more rapidly than by air, it is apt to cool the body unequally by acting more on one part than on another; and chilling results. Moreover, clothing material that is good conducting material is as a rule less permeable to moisture, and would prevent the due evaporation of sweat, which would then condense upon the skin. Thus the loss of heat from the body would be accelerated in one way, and retarded in another, and in the chief way; while the risks of too rapid cooling of parts of the body would be incurred. In summer then the action of the skin would be aided by non-conducting material, which allowed free passage to the exhaled vapours, not only by the nature of the substance of which it was made, but also by the thinness and openness of texture of the cloth.

The Qualities of Suitable Clothing we are now prepared to understand more fully. (1) It should be made of material which is a bad conductor of heat. (2) The material should readily absorb moisture, so that the vapour of perspiration may be allowed to pass off from the body, and may not be caused to accumulate between the clothing and the skin, leading to condensation. (3) It should be more or less porous in texture, by which is meant that the cloth should be able to contain air in its meshes or fine channels. This will effect two objects. Air is a bad conductor, and a cloth which is so woven that it may contain a considerable quantity of air will be a better non-conductor than one of the same thickness so closely woven as to retain little air. The more porous material will, secondly, allow of movement of air in its meshes, of ventilation that is to say, and will be better adapted to permit due exhalation from the skin. These qualities of clothing we shall now consider in some detail, in order to learn what kinds of material possess them to greatest extent.

Clothing as a Conductor of Heat.—The following list shows the relative position which the different materials, used for clothing, occupy, the best conductors being placed at the head.

Flax and linen,
Cotton and calico,
Silk,
Wool,
Eider-down,
Fur.

The fur of the hare, according to Rumford, conducts least of all substances used for clothing, and next to it come down and wool. According to the same authority, if the conducting power of linen be represented by 100 that of wool is from 50 to 70. Putting this in a popular way, of two coverings of linen and of wool both of the same thickness and texture, the woollen one would be nearly twice as warm as the linen one. Though it is put in this way it must be remembered that there is no actual warmth in either, the meaning is simply that the linen conducts the heat away with nearly twice the rapidity of the wool; that the wool, in other words, retains the heat and thus maintains the warmth of the body. In the same way the woollen material would retard the excess of heat from the outside. Thus ice wrapped up in wool will melt more slowly than if exposed to the warm external air, for the wool keeps out the heat. Between linen and cotton cloth—calico—there is no great difference. Thus, in an

experiment, the same degree of heat was imparted to linen and calico, and it was found that the former cooled down in 10½ minutes and the latter in 11½. Linen is, however, actually the best conductor of all materials used for clothing, and, therefore, the least desirable of material for that purpose. This conduction of heat is not affected by colour; it is determined by the material of which the clothing is made. Moreover it is to be distinguished from the absorption and emission of heat, which colour affects to a considerable extent. What is meant by the absorption and emission of heat will be understood by comparing heat to light. A substance which permits light to pass is called transparent, it does not absorb the light; a substance which absorbs the light—does not permit it to pass—is called opaque. Now we may say some substances are transparent to heat, that is, they allow the heat to pass through without absorbing it, so that in consequence they do not become warm. This is true of air, the heat rays from the sun or from a fire pass through it without warming it. Other substances do not permit the heat to pass through, they are opaque to it, so to speak, they absorb it. Substances which absorb heat also give out the heat or emit it, later. Thus glass is transparent to light, but it is not so to heat. It absorbs the heat rays. If one is sitting in front of a fire and, feeling the heat too great, interposes a screen of glass, at once the intense heat is diminished, but the light is unaffected, the fire is plainly seen through the glass screen. The screen has been cold before it was placed in front of the fire, but it soon grows warm; that is to say, it intercepts or absorbs the heat rays, and therefore becomes warm, and by and by emits the heat. It is useful under such circumstances, for it prevents the heat being poured in a too intense stream on one place; but the heat is not lost. It is given out later in a more gradual and pleasant fashion, warming the room more regularly and comfortably. This illustrates what is meant by absorption and emission of heat, and how it differs from conduction, for glass is not a good conductor. In the same way clothing may absorb heat and emit heat apart altogether from conducting power. While colour does not influence the conduction of heat to any extent, it seems to have a marked influence on the absorption of heat. This is of importance as regards the gain of heat to the body from without. Thus suppose two garments of the same material, thickness &c., but one black and the other white, and suppose the sun's rays to be playing equally upon both, the black garment will absorb much more heat than the white one because of its colour alone, and the individual wearing the black one will feel the heat much more intensely than the individual wearing the white garment. Thus experiments were made to determine the amount of heat that would be absorbed in the same time by material made of different substances, cotton, linen, flannel, and silk, but all white, and comparatively little difference was found between them. When, however, shirtings *all made of the same material*, were used, but *all of different colours*, the amount of heat absorbed was found to vary very markedly with the colour.

Thus when white shirting	absorbed	heat to	raise it to	100° F.
pale-straw shirting	,,	,,	,,	102° ,,
dark-yellow ,,	,,	,,	,,	140° ,,
light-green ,,	,,	,,	,,	155° ,,
dark-green ,,	,,	,,	,,	168° ,,
turkey-red ,,	,,	,,	,,	165° ,,
light-blue ,,	,,	,,	,,	198° ,,
black ,,	,,	,,	,,	208° ,,

Scientific facts are, therefore, in agreement with the facts of experience in testifying that light-coloured garments are coolest for summer wear, and dark-coloured warmest for winter wear, not because they conduct the heat differently, but because the light garment absorbs least of the sun's rays and black absorbs most. So in summer we use the garment which, because of its colour, will refuse to absorb much heat, and in winter we adopt the colour which will absorb most and aid in keeping up our bodily warmth.

The Absorption of Moisture by Clothing.—The power of absorbing moisture is a most important quality of clothing. It is according to the degree to which clothing absorbs moisture that it does not interfere with the natural exhalation from the skin. If the material covering the body readily takes up vapour, then the perspiration passes into the clothing and is given off on the outside; but if the absorptive power of the clothing is little, the body is kept enveloped in an atmosphere saturated with vapour, and with the slightest exertion becomes bedewed with moisture—a most uncomfortable

position to be in, and one which is attended by considerable risk of catching cold, as we all know. This quality of absorbing moisture is called the **hygroscopic property** of clothing material. This property has received careful investigation at the hands of Pettenkofer, who took pieces of different materials, all of the same size and weight, and having carefully dried them at 212°, weighed them, and thereafter exposed them to the atmosphere of different places, more or less damp, for varying periods. He then weighed them to discover how much moisture had been absorbed. The following are some of his results:—

After 12 hours in a cellar	there had been absorbed	by linen	77	parts of water,	by flannel	157	parts.
,, ,, ,, room	,, ,,	,,	41	,,	,,	75	,,
,, ,, ,, laboratory	,, ,,	,,	69	,,	,,	105	,,
,, 10 minutes ,, room	,, ,,	,,	73	,,	,,	113	,,

Results of other observations are shown in the following table. Various materials were taken of the same weight, dried in a hot chamber for 24 hours, and then exposed (1) for 48 hours in a cold uninhabited room, and then weighed. The same materials after drying were exposed (2) for 72 hours in a damp cellar, and thereafter weighed. The results were as follows:—

	Weight at the End of the 1st Experiment.	Weight at the End of the 2nd Experiment.
Sheep's wool,	1084	1163
Fur,	1072	1125
Eider-down,	1067	1112
Silk,	1057	1107
Linen,	1046	1102
Cotton,	1043	1089

The weight of each substance before exposure was 1000.

With flannel, according to Pettenkofer the maximum power of absorbing water is represented by 174 and the minimum 111, while with linen the maximum was 75 and the minimum 41. He took two pieces of flannel and linen of equal weight, put them into water, and then wrung them out till no more water could be squeezed out. He found that for every 1000 parts of weight of the flannel 913 parts of water were retained, and for every 1000 parts of linen only 740 of water were retained. He also proceeded to determine the rate at which wool and linen gave off water with which they had been wetted, and observed that wool dried more regularly than linen, the water being given off rapidly from the linen at first and then more slowly, but from wool with less rapidity to begin with but more steadily, so that in the end more water was given off from the wool than from the linen in the same time.

Now what is the bearing of these facts? It will be observed that the order of absorptive power for moisture is just the order of non-conducting power for heat, so that the clothing material which conducts heat least is the material which absorbs moisture most. Such clothing, when covering the body, will conduct the heat from the body with least rapidity but will interfere least with the natural evaporation of sweat. These, as we have seen, are exactly the conditions one desires in suitable clothing. It is the kind of covering for the body which will interfere least with the natural means by which the body regulates its temperature. Suppose the body to be engaged in active exercise, by which a large amount of perspiration is induced: if linen be next the skin, it will speedily become saturated with moisture, and the uncomfortable feeling of soaking garments will soon arise. If woollen clothing be worn, the wool will absorb much more moisture before it becomes saturated, and the active exercise will be engaged in for a considerably longer period before the discomfort is experienced. Then suppose the person sits down to rest, rapid evaporation will immediately take place from the linen, and the heat of the body will be quickly reduced, a feeling of chilliness being the result, while the evaporation from the woollen material will be more gradual, so that a natural process of cooling will result with much less chance of chilliness. "In other words, a person after violent exertion may sit down on a cool bank, if dressed in a flannel shirt, with less danger than if his dress were linen."

There is another point of view from which this quality of clothing must be considered. Suppose the moisture does not come from the body but is external, suppose, that is, that one is in a damp atmosphere, then the woollen clothing will absorb the moisture from without more rapidly than the linen; and this may seem to be to the disadvantage of the former. But then the woollen clothing will be able to take up more water before it is saturated than the linen, which will become speedily soaked, so that the disadvantage is, in this way, counterbalanced. One will, therefore, be able to bear exposure to the damp atmosphere longer without discomfort when clothed with woollen material.

Clothing can be made impermeable to moisture by various means, and the body may thus be protected from external damp by an outer covering of impermeable substance. This will appear all the more desirable when we consider the greatly increased weight woollen garments must have when soaked with moisture. If 1000 parts of flannel can take up 157 parts of water, a woollen garment which, when dry, weighs 10 pounds may take up enough moisture to weigh 11½ pounds. The added weight which the body will thus require to carry, if one wears a long heavy woollen garment, such as an "ulster," is not too insignificant to be taken into account. Impermeability to moisture is conferred on cloth by various methods. Mackintosh's patent, by which what is called Mackintosh is produced, applies a varnish made of a solution of caoutchouc in rectified petroleum or naphtha between two layers of cloth. A similar varnish may be laid on one side only of the cloth. A solution of caoutchouc in linseed-oil is also employed, and linseed-oil boiled with sugar of lead. A solution of soap may be also used worked into the cloth and then acted on by a solution of alum. This prevents the passage of water into the pores of the cloth; or if the cloth be impregnated with a solution of isinglass or glue, and then acted on by a clear infusion of galls, a similar effect is produced. For rougher material hot tar is employed. Of all these methods those of Mackintosh are the most used, the solution being applied either between two layers of cloth or on the outside of the cloth. The cloth prepared by the first method is most sought, because of its appearance, but that prepared by the second is in some respects the better, because, being quite on the outside, it prevents any moisture being taken up from without, while, in the former case, the outer layer of cloth becomes soaked and consequently heavier.

Such impermeable material, however, illustrates the disadvantages of wearing clothing not capable of absorbing moisture, if it be worn for any time. The natural evaporation from the body is interfered with, and a feeling of oppression is produced, while perspiration collects on the skin. Such material should, therefore, be worn for as brief a period as is really necessary, and should be removed as soon as the necessity is passed.

The Porosity of Clothing depends to some extent upon the material of which it is made, but chiefly on the manner in which the cloth has been woven, its closeness of texture being the chief circumstance modifying it. By porosity is meant the extent to which air may penetrate the cloth, because of spaces, channels, pores &c. The porosity of various materials has been determined by finding the amount of air that could be forced through a piece of the cloth with a certain pressure in a given time.

Through	flannel	10·41	measures of air passed.
,,	lambskin	6·07	,, ,, ,,
,,	linen	6·03	,, ,, ,,
,,	wash-leather	5·37	,, ,, ,,
,,	silk fabric	4·14	,, ,, ,,
,,	glove-leather	·15	,, ,, ,,

Pettenkofer obtained results showing that in the same time in which flannel allowed 100 measures of air to pass

Linen and buckskin	allowed	only	58
Chamois	,,	,,	51
Silk	,,	,,	40
Kid	,,	,,	1

In short the clothing that experience admits to be the warmest is that which conducts heat least, absorbs water most easily and allows the air the freest passage. That clothing which permits air to pass most readily should be the warmest may seem at first sight to be strange and unexpected. When we consider, however, that the meshes and canals of porous clothing are filled with air, and that air is a non-conductor of heat, the explanation is forthcoming. To speak of a covering of air might seem an absurdity, but in plain fact when one wears a porous garment one is kept warm, not by the cloth covering alone, but also by the layers of air which occupy the interstices of the cloth. Now the porous garment will readily admit of the removal of the products of perspiration, and will not interfere with the function of the skin.

The porosity of clothing has a marked relationship to the non-conducting power of cloth. The conducting power of a material does not depend upon porosity but upon the nature of the material itself. Nevertheless the looseness or closeness of the texture of the cloth will modify the conducting power, just because with a loose cloth the non-conducting power of air is brought also into play. Thus Krieger employed tin cylinders which he filled with hot water, and he noted the rate at which the cylinders cooled when they were enveloped with different substances. In one observation he covered the cylinders with loose common wadding, and found the tin parted with its heat slowly: then he compressed the wadding, and the temperature fell much more rapidly. In short by compressing the wool he diminished the air spaces in the wool,

and expelled much of the air, and thus lost the benefit of the air covering. For similar reasons a tightly-fitting covering permits of a more rapid loss of heat than a loosely-fitting one. The tightly-fitting one, by its close application to the body it covers, permits the full action of any conducting power the garment may possess; while the loosely-fitting one has its conducting power for heat largely set aside because a layer of air is interposed between the garment and the body. In the sense already explained a person who wears loosely-fitting clothing may be said to wear next the skin a garment of air, and retains much warmth of body on that account. This explains also how it comes about that two thin garments are warmer than one garment equal in thickness to the two put together. The two garments have between them a layer of air and thus actually present a greater thickness of non-conducting material, because of the film of air, than the single thick garment. For this reason it is better, instead of having light flannels for summer wear and heavy flannels for winter wear, to use the same thinness of flannel summer and winter, but to put on more in winter than in summer, to wear two in winter and one in summer.

Practical Conclusions regarding Material for Clothing.—The facts that have been considered show that under all circumstances woollen material is the most suitable for clothing. It conducts heat least, it absorbs most moisture, and it permits most readily the passage of air. It is well fitted to aid the skin in maintaining a normal temperature, without interfering with the proper functions of the skin as an organ of excretion (see p. 308). For summer or for winter it is alike valuable, modifications in the quantity of clothing worn, in the number of garments, in the closeness or openness of the texture, being alone necessary to meet the very different conditions of summer's heat and winter's frost. While valuable in every climate, in none is it more valuable than in that of the British Islands, where dampness and rawness of atmosphere are prevailing characteristics, because, by its ability to absorb a large amount of moisture before being saturated, and afterwards to permit the moisture to evaporate gradually, it prevents sudden and great diminution of the bodily temperature, which would certainly be the result of cotton or linen clothing. For precisely the same reasons is it pre-eminently valuable in hot climates, where the intense heat of the day gives place, immediately on sundown, to a rapid cooling; when persons are at one time broiling in the sun and soon afterwards shivering with cold. It is these sudden changes of temperature that clothing should be specially fitted to modify, and no article of clothing material is so suitable for such a purpose as wool. Again it is the best protection to the person who, for one reason or another, has little active exercise to assist in the production of heat within the body; and it is the only really safe article of clothing for any engaged in very active or even violent exercise followed by periods of inaction, as in the games of cricket, football, tennis &c. At the period of violent exercise the person wearing woollen garments will certainly feel warmer than another clothed in cotton or linen, but the woollen material permits the normal activity of the skin in its effort to maintain the balance, while the cotton or linen upsets it by greatly increasing the conduction of the heat from the body. The result is seen as soon as a pause in the exertion occurs, when the person clothed in cotton becomes aware that his clothing is soaked with perspiration and fears he will begin to feel chilly immediately, while the other individual is quietly, naturally and comfortably cooling down. Woollen clothing should then always be worn next the skin. The garment should be of only moderate thickness, not too close in texture, and should not be tight fitting. Whenever it becomes necessary to increase the amount of clothing it should be preferably by the addition of another garment to the first, not by substituting a thicker one for the first.

In cold weather the garment should be black or of a dark colour, in hot countries or at hot seasons it should be white or light-gray.

Knitted woollen underclothing is the best, but it should be neither too fine nor too close. It used to be objected to woollen underclothing that it was too heavy for summer weather. But woollen garments can be obtained of any required thickness, and a woollen garment of the same weight as a linen one is much warmer. An objection in which there is more of truth is that woollen material next the skin is irritating. It undoubtedly stimulates the skin, and if rough reddens it markedly. Flannel especially has such a disadvantage. But of recent years so much attention has been given to the manufacture of the wool for such purposes and to the knitting of undergarments, that the objection has now much less force. Woollen underclothing can be obtained as soft and fine and non-irritating almost as any linen garment could be. There are, however, a few people, not many,

who find wool next the skin really irritating, no matter in what form it is. They should not, therefore, abandon woollen underclothing, but may protect the skin by interposing between it and the wool a fine large-meshed gauze garment. In such cases silk might be worn next the skin.

One objection, however, to woollen underclothing of some force is that it shows dirt much less quickly than other materials, and that, in consequence, it is often worn unchanged for far too long a period. This, however, is scarcely a disadvantage pertaining to the material itself, but properly is an evil to be laid to the door of the wearer.

Inflammability of Clothing.—It is worthy of notice that woollen material, which we have found so thoroughly to answer all the requirements of healthy clothing, is also one of the substances least open to objection on the ground of risk of catching fire. It will burn slowly, will smoulder, but will not easily burst into flame. Cotton and linen, on the other hand, will readily burst into flame and be rapidly consumed. A linen or cotton dress, pinafore, or apron, taking fire will speedily flare up, the flame spreading from one part to another, till the whole is in a blaze, and the flame is not easily altogether extinguished. When such a garment catches fire, serious and fatal injury may be occasioned before it is put out. If a woollen garment is similarly exposed, the fire does not quickly extend, is more limited to the one place, and may thus be arrested before harm is done. The more dense the fabric the more slowly does the combustion proceed. Leather has a similar advantage. Silk is more inflammable than wool, but much less so than either cotton or linen. Whenever the occupation exposes the person to risks of fire, woollen material should invariably be selected. Of all articles of dress, muslin, from its openness of texture, is most dangerous. The plan of extinguishing fire on clothing by enveloping the person in a blanket, rug, shawl &c. is based upon the small inflammability of the wool of which the blanket &c. is formed.

It is possible, however, to render linen, muslin and other cotton goods non-inflammable by impregnating them with some material, which resists fire. Of such substances the most useful is tungstate of soda, and molybdate of soda. The former is that chiefly used. These substances are dissolved out in washing, however, and the material requires re-treatment with the solution after each washing. The tungstate of soda permits the material to be ironed without change being produced; it does not injure the material either in texture or appearance, nor does it affect the colour. Other substances, used for the same purpose, either do not stand ironing, or change the colour of the garment, or give the material an unfinished appearance. Sulphate of ammonia, for example, which is cheap, a ten-per-cent solution of which renders a garment, dipped into it and then dried, non-inflammable, affects some colours, especially madder-purple. Phosphate of ammonia, also used, gives a "chalky" finish. Material made of asbestos absolutely resists fire. It may be heated to redness without being consumed. The other materials chemically treated, while they do not burst into flame, will yet become charred. "Fire-proof starch," recommended for muslins, &c. is starch prepared with tungstate of soda; and when used as ordinary starch it renders the material non-inflammable.

The Shape and Form of Clothing should have regard to these conditions: (1) The clothing should not be tight-fitting, for reasons explained in the paragraphs relating to porosity of clothing; (2) It should not be redundant, necessitating the stowing away of unnecessary material; (3) It should nowhere exert undue constriction on any part. Increased tightness anywhere inevitably interferes to a greater or less extent with the normal circulation of the blood, leading to deficiency of supply of blood to the parts beyond the line of constriction and consequent coldness, or more certainly to slowing of the blood current returning by veins to the heart. A good illustration of this is the aggravation of varicose veins by constriction, as by the use of tight garters.

Underclothing should always and everywhere be of wool, for reasons already sufficiently explained in the preceding paragraphs. If it prove, as it sometimes, but not often, does, too irritating to the skin, a fine open-meshed garment of silk or lawn may be interposed between the woollen garment and the skin.

Night Garments should be of wool for the young, for the old and feeble, and for delicate persons, those liable to cold, lung affections, and for the rheumatic. In very cold climates they may be necessary for all, and they should certainly be worn by any, who are frequently required to get out of bed during the night. For persons in full health and vigour, however, under ordinary circumstances, a cotton or linen night-dress is to be preferred. It is far cleanlier to begin with. In bed, moreover, circum-

stances do not demand warm clothing. There is no exercise to induce perspiration. There are no sudden changes of temperature to be guarded against. There is no conduction away of heat to be feared. The bed-clothes should offer sufficient protection against that; and under such circumstances cleanliness is the main consideration. Moreover the stimulating effects of the wool in direct contact with the skin are not desired in bed, as they would tend to produce too great a feeling of warmth, and the skin to some extent should be allowed to share in the rest permitted to the other parts of the body.

"A man might as well sleep in his boots as seek repose in a night-cap," says Mr. Treeves, the London surgeon; and "for the majority of individuals the night-cap is no more an essential to health than it is a contribution to personal beauty." If that is true as regards men it is still more true when applied to women, whose copious hair affords all necessary protection.

Dress for Women and Children has already been sufficiently considered in pages 472, 444, and 452. It is only necessary to say that the reasons given for woollen underclothing apply to them with full force, in some respects with even greater force than to men, for women have, as a rule, less active lives than men, and children are much less able to stand any exposure to cold.

Dress for Men should fulfil the conditions already stated at length. Trousers should be suspended by braces from the shoulder, not by belts or straps, which exert undue pressure on the abdominal organs, and thus may increase any tendency to rupture. Still more are such appliances hurtful, or likely to be so, when used to enable increased exertion to be put forth, as in running, leaping &c.

Covering for the Head.—The hair is the natural covering for the head. It is a bad conductor of heat, it allows free evaporation of moisture, it is porous, and it is light. Thus it exhibits all the conditions of suitable clothing, and in its natural state is thus well fitted to afford protection to the head. In its natural state, we say, but it is seldom permitted to be in its natural state, for, when well oiled and well brushed down, it is both a better conductor and less porous than it ought to be. If oil or pomade be necessary for keeping a tidy arrangement of the hair, only so much should be used as is really necessary for that purpose. That the hair is in ordinary circumstances quite an efficient protection is proved by the large number of persons, even in the uncertain climate of Britain, who habitually use no additional covering. Some covering is, however, used by most people in civilized countries, partly for tidiness sake, and partly as an extra protection against cold, wet, or heat, as well as because custom demands it. Such additional protection should fulfil the same conditions applicable to coverings for any other part of the body. It ought not to conduct heat, it ought to allow evaporation of the perspiration from the scalp, it should not be heavy, nor should it constrict any part of the head. The ordinary tall hat worn by men violates all these conditions. It very commonly catches at front and behind; it is very likely to be heavy; and for want of ventilation it becomes a hot-air box confining the vapours from the scalp. Its faults are most conspicuous in summer, particularly when it is black in colour. It is, thus, prone to produce a feeling of weight and oppression and perhaps headache. Felt is an appropriate material for hats; and there ought to be no difficulty in making them properly fitting and light, but ventilation is not so easily effected, since that implies an opening for the entrance of fresh air as well as an outlet for the escape of exhaled vapour. Woollen or flannel caps need no such provision since they are made of porous material, provided that material is not of too close texture. Straw hats fulfil all the required conditions.

For protection against heat, the heat of the sun in summer, for example, the head covering should be of white material, and should be so shaped as to shield the back of the head as well as the top and the face. The ordinary broad-brimmed straw hat is the most useful for such a purpose. In excessively hot climates the back of the neck should also be protected by it. It should be so made as to permit the free passage of air through it. For India the pith or bamboo-wicker helmets, covered with cotton, are said to be the most suitable head covering, being of great advantage in diminishing the risk of sunstroke. In excessively cold climates, again, fur caps are the most suitable.

Covering for the Feet.—It ought not to be necessary to consider what is the appropriate covering for various parts of the body in detail, since the same conditions, already laid down on p. 729 and the preceding pages apply equally strongly to all parts of the body. We need only refer to one or two points in the clothing of the feet which transgress these conditions. If the general surface of the body should be clothed in non-conducting material, much more ought the feet which come into more or less direct contact with the ground, and can, therefore, be

more readily robbed of heat than other parts of the body. Cotton socks or stockings ought, therefore, never to be worn, but always woollen, the thickness being dependent upon the season. It should also be noted that if socks or stockings are knitted of too hard wool and too closely, they are less porous, contain less air in their meshes, will be more easily soaked and matted with moisture, and will afford less protection against loss of heat in cold and wet weather. Stockings or socks with a compartment for each toe, as gloves have for each finger, are warmer, more cleanly, and more likely to be better fitting than the ordinary kind. Then tight-fitting stockings are less warm and comfortable than the more loosely fitting, provided the latter do not exhibit the fault of the other extreme of too much material, requiring to be crumpled up in the boot. What has been said should also show how great an evil garters are. If they are to be useful at all they must be tight, and if tight they compress the veins, preventing the due return of blood from the foot and leg. The sluggish circulation thus induced is a frequent cause of cold feet, and of pain and weariness in the limbs of which women so commonly complain. It is besides a serious cause of enlarged (varicose) veins. Stockings should, therefore, always be kept up by "suspenders."

Boots are commonly far too stiff and unyielding to permit the movement of the foot proper to walking, unless in the case of women's boots when they often are far too thin to yield protection against cold or wet or even the mechanical discomfort of a gravelled walk. The spring of the step is taken from the ball of the toes, and here the boot should yield easily, so that a person ought to be able to stand on tiptoes almost as readily with boots as without them, the boot bending as the foot does. Unyielding boots not only interfere with this movement, but indeed with the free play of the whole foot, so that all the mechanical advantage and elasticity, derived from the foot being formed of numerous bones, jointed so as to form an arch across the foot as well as from heel to toes, is lost; and the foot moves in its inclosing box as a solid mass and not as a yielding elastic structure. The result of the constant wearing of such boots is that the foot actually loses its natural elasticity; the muscles of the foot not being allowed free exercise do not attain to full development and are permanently weak, and walking is a labour instead of a pleasure. Obviously the natural movement of the foot will not be permitted in boots which are made without regard to the shape of the foot. The outline of the foot should, therefore, determine the shape of the boot. In this respect many boots err in the narrowing towards the toes, which crushes the toes together, causing one to ride over the other. The heel, which ought to be nearly as large as the ball of the heel itself, is usually too small, too high, and placed too far forward. The high heel throws the body into the position approaching that of the person, walking on his toes, and disturbs the natural balance of the body, so that to maintain the erect posture more muscular effort is required, while its forward position practically destroys the value of the arch of the foot from before backwards. The weight of the body being thus thrown forward crushes the toes forwards against the points of the boots, and tends to bend the toes, and to press unduly upon the nails, deforming them and occasioning ingrowing toe-nails. The small heel affords far too narrow a basis of support, so that the body is unstable. For a man the heel should not be more than $\frac{3}{4}$ths inch high and should be placed well back. Boots, if properly fitting and of pliable material, do not press unequally upon any part, and thus avoid the causes of the production of corns and bunions, the result of undue and unequal pressure. At the same time boots ought not to be so large as to permit the feet to move about loosely within them. The friction so produced would quickly raise blisters and cause thickenings of the skin.

How often are all the evils that have been indicated exemplified to the full in the boots of children! They are bought large to suit their growth, and heavy that they may the less easily be knocked to pieces, and they are made to pass up the leg to give additional support to the ankles!!! So the child's feet are tied up in a box, and her toes are twisted and squeezed into a shape nature would never have produced, and muscle is wasted for the sake of economy in shoe leather, and the surest of all methods is adopted to produce weak ankles instead of avoiding them. The moderate and natural use of a part is the best means of strengthening it. It is with regular, but not excessive, exercise that muscles grow strong and well-formed. When such exercise is prevented by artificial bands and strappings, the surest means of inducing weakness are being adopted. Special care ought, therefore, to be taken with the covering for children's feet, since the growth will be powerfully affected by the nature of that covering. Probably shoes would be more

suited than boots, since they allow a freer action of the ankle joint, and they also allow, better than boots, of the escape of moisture from the feet. If, from the beginning, the child's feet are allowed free play in well-fitting shoes, pliable, and not so heavy as to tire out the young muscles with lifting them, there need be little fear of badly-shaped feet or weak ankles. But if under the name of strengthening weak joints, the natural growth and exercise of the muscles and ligaments of the foot and ankle are interfered with, weakness will certainly result, and the necessity of external support will become more pronounced as the child grows. The weakness, in short, which the mother points to as the proof of the need of the external support, is the result of the support.

Poisonous Dyes in Clothing.—There are on record numerous instances in which symptoms of poisoning have been traced to the clothing worn, dependent upon the stuff used to dye the material. The poison to be feared is arsenic, some of the preparations of which may be deliberately used for colouring purposes, such as the arsenite of copper, which is green; while some forms of arsenic are found as impurities in other colours employed. Thus magenta (rosanaline or fuchsine) which when pure is harmless, is sometimes contaminated with arsenic, and most of the cases of poisoning from clothing have been owing to this dye in the cloth. In the pigments known as cochineal red and coralline it has also been found. The effects so produced may be twofold. Arsenical vapour or dust may be given off from the fabric and be inhaled, leading to symptoms of chronic poisoning, perhaps for a long time not recognized as such. The usual symptoms are headache, sickness, loss of appetite, languor, feverishness &c. In the second place the clothing may directly irritate the skin, leading to redness, swelling and inflammation of the skin, producing perhaps an eruption. In all kinds of printed and woven materials, used for clothing, has arsenic been found, in flannel vests and shirts, in socks and stockings, in hats and gloves, in artificial leaves and flowers, as well as in table-cloths, carpets, wall-papers &c. It may be well to observe also that clothing is capable of absorbing not only moisture but also odours and emanations of various kinds. The extent to which such absorption occurs depends to some extent upon the colour of the cloth, black absorbing most, then the other colours in the following order—

Blue – Red – Green – Yellow – White;

the last absorbing least. That the contagion of infectious disease clings tenaciously to clothing and may be easily transported from place to place by it is well known, and is a means of spreading such diseases not too carefully guarded against. The relation between the absorption of odours and colour would seem to indicate that nurses in attendance upon any infectious disease should be clad in light-coloured washing dresses and not in dark garments.

BATHING.

The Uses of Bathing.—The primary use of the bath is for the promotion of cleanliness. Both from within and from without do materials accumulate upon the skin which, if allowed to remain, interfere with the proper and healthy discharge of its business in the bodily economy. On p. 387 and following pages the nature of that business has been pointed out. By means of the sweat-glands, and the sebaceous glands connected with the hairs, material is constantly being removed from the blood for expulsion from the body. But these glands may become easily blocked at their outlet, the excretion escaping with difficulty. From the surface of the skin dried scales of the scarf-skin are being separated in the form of fine dust. These, mingling with the moisture from the sweat-glands and the oily material from the hair-glands, form a material, readily remaining upon the skin, covering over the minute openings of the glands, and so interfering with the function of the skin, diminishing its activity as a purifier of the blood, and possibly leading to disease. Then from without dust &c. settles upon the skin increasing its defilement. The primary use of bathing is to cleanse the skin from such impurities. For these purposes the regular use of cold or tepid water with soap is effective, but it is not completely so. It removes the surface material but has less effect on the deeper parts of the glands, which are more effectually cleansed by the common practice of the weekly warm bath. By the latter means what may be called a flushing of the tubes of the glands is produced. The warmth brings a large supply of blood to the skin, and stimulates the glands to increased activity. The increased quantity of sweat thus produced causes, so to speak, a flow down the tubes and washes out any material which may have collected in their interior, which the daily wash may not have been sufficient to remove. This is even more thoroughly effected by the hot-air bath, one of the features of the Turkish bath. This is, indeed, one of the most valuable effects of the hot-air bath, the very copious

perspiration produced by the action of the hot air on the skin causing a very thorough clearing out of the gland-tubes or "pores of the skin," as they are commonly called. So that so far as cleansing purposes are concerned, the daily ablutions with soap and water, the weekly warm bath, and an occasional hot-air bath would be a most excellent arrangement.

All water for ordinary bathing purposes ought to be soft. The softer it is, the greater is its cleansing property, because the more readily does it soften and dissolve impurities. Besides, hard waters are liable to irritate the skin, and many persons are very liable to such irritation; and hard waters are very uneconomical in soap. The methods of softening hard waters have been explained on p. 639. Rain-water properly purified would be extremely useful for cleansing purposes, where the domestic supply was of hard water. The mere act of boiling water softens it (p. 639), and thus hard water used for hot baths will be less disadvantageous than if the water were used cold. But a suggestion has been made by which, by simple and not expensive means, a supply of distilled water for washing purposes might readily be obtained in every house provided with a hot-water boiler. Such boilers are all provided with a pipe by which the steam blows off. This usually discharges into the open air. If this pipe were made in a spiral form, carried through a small tank of cold water and then made to open into a cistern, the steam would be condensed and caught as distilled water in the cistern, from which it could be drawn off as required.

Soap is prepared by boiling fat, derived from the ox or sheep and vegetable substances, with caustic-soda solution, a hard soap being thus produced; soft soap is the product of boiling fat with caustic potash. The oil from the olive mixed with other vegetable oils is used for Castile soap, the white variety of which is one of the most excellent and soothing quality. Palm-oil, cocoa-nut oil, and other vegetable oils are used for the same purpose. Curd soap, when pure, is made from tallow and soda only, and is of good quality. Curd soap and palm-oil soap are the usual basis of most toilet soaps, to which a proportion of glycerine may be added, in the glycerine soaps, and to which also colouring matters and various perfumes are added. Some colouring agents are injurious; red and magenta colours should be avoided, the red colour being sometimes derived from a mercury or lead preparation, and the magenta colouring matter being liable to contamination with arsenic. The safest soaps to use for the skin are the pure white curd or Castile soaps, and the transparent soaps of makers of repute. The transparent soaps are less likely to be adulterated than others, since adulteration would interfere with their clearness. An excess of soap will unduly soften the skin, owing to the action of the soda, and therefore the smallest quantity that is suitable should be employed, and very thoroughly washed off afterwards with water. None should be left for removal by the towel.

The use of the hands is to be preferred to sponges, flannel cloths &c., for the fingers can more effectually insinuate themselves into the folds of the skin and the due amount of pressure can be better regulated. The friction of the hand is also pleasantly stimulating to the skin.

The bath, however, serves other purposes than those of cleansing, though none more valuable. The hot bath relaxes the blood-vessels of the surface and causes a freer circulation in the skin. If more blood flows to the skin there is, of necessity, less in deeper organs, which are consequently relieved, and a soothing and calming effect is thus produced. None of the organs of the body experiences such effects more markedly than the nervous system, and the effect of the hot bath in inducing sleep is thus explained. The cold bath, on the other hand, drives the blood to the deeper parts and promotes their activity, though, if the cold be not too prolonged, reaction sets in when it is over, blood flows more freely to the skin, and a general stimulating effect is produced. For such reasons the evening, before retiring to rest, is the most suitable time for the warm bath, and the morning after rising for the cold bath, the former conducing to rest, the latter to activity. Various methods are employed for concentrating the action of one or other on special parts or organs of the body, such as by the hip or sitz bath, douch and needle baths and so on, which will be considered in a little more detail. Thus baths are made use of not only for the ordinary purposes of health, but also for the treatment of disordered states of the body, their value for which has been recognized only in recent years.

Too frequent bathing of the skin, whether of one part or of the whole surface is not commended, specially if each time soap is employed. The oily matter produced by the sebaceous glands is designed to oil the skin and keep it soft and pliable. If it is too frequently removed, the skin becomes too dry and is prone

to crack or chap. Other consequences may ensue from the skin being irritated by the excessive stimulation, such as the production of eruptions and so on. The skin of some is much more susceptible to such influences than that of others. For example some can scarcely use soap to the face, because of the irritation it induces. In such cases the addition to the water used of a few drops of weak ammonia, spirits of hartshorn, or a tea-spoonful of sal volatile, will effect the removal of oily matter from the surface without irritation.

Varieties of Baths.—The temperature of the various kinds of baths is given in the following table:

Cold Bath	50° to	70°	Fahrenheit.
Tepid ,,	85° ,,	95°	,,
Warm ,,	96° ,,	104°	,,
Vapour ,,	96° ,,	110°	,,
Hot ,,	102° ,,	110°	,,
Very hot ,,	110° ,,	120°	,,
Hot-air[1] ,,	175° ,,	212°	,,

The Cold Bath.—The first effect of the cold bath is to produce a shock on the nerves of the skin. As a result the vessels of the skin become strongly contracted, the blood is driven out of them and seeks the deeper parts, which also will be suddenly excited by the rush of blood to them. Proof of this is found in the increased rate of the heart's beat and the quickening of the breathing. The temperature of the skin is reduced, but not that of the body as a whole, unless the immersion be prolonged. Indeed at first the internal production of heat is quickened by the stimulus to the internal organs. If, however, the application of the cold be prolonged the temperature of the body will be lowered, because water is a conductor of heat, and heat will be removed from the body more quickly than it is produced. For such a purpose cold baths are largely employed in Germany in cases of fever. The prolonged action produces depression, the action of the heart becoming feebler and slower, due to the action of the cold upon the nervous system as well as to the direct abstraction of heat. For recovery from such depression artificial aid, in the shape of hot blankets &c. and stimulants might be necessary. But in the case of the cold bath as ordinarily used, the application is short, and the more near to the temperature of 50° Fahr. the water is the shorter must it be. Following the first action is reaction, during which the blood returns to the skin, the blood-vessels of which relax, and a pleasant sensation of "glow," spreading rapidly over the surface, is experienced. This reaction is aided by rapid friction of the skin, as by towels, and if, after drying, the body is quickly clothed and exercise engaged in, the total effect of the bath is stimulating, inducing a feeling not only of warmth but also of vigour. The markedly stimulating effect on the various organs of the body is shown by the fact that the amount of carbonic acid gas given off from the lungs and of urea from the kidneys is increased, indicating increased tissue change, evidenced also by increased appetite. The length of time the cold may be applied without interfering with the setting in of a proper reaction depends upon the individual. A mere instant's immersion is sufficient for some, others can bear several minutes, while some could not bear complete immersion of the body at all, a feeling of coldness and shivering lasting for hours after it. Obviously for such persons the full cold bath is not suitable, but that does not necessarily imply that the use of cold water to the body is to them hurtful in every form. Much depends on habit, and a person unaccustomed to the full cold bath is not likely to find it pleasant without some preparation for it. This preparation can be given by the use of the cold wet towel &c. for some time, gradually leading up to the full cold plunge, which may thus be made tolerable and enjoyable.

The cold bath is not suitable for the old and the delicate. The shock is too great, and a proper reaction does not set in. Besides in delicate persons the rush of blood to the deeper organs may produce too great a strain upon weak parts. Of course old persons who have been accustomed all their lives to the cold bath need not break it off, if it continues to agree with them, or they may simply modify it by using some of the milder forms to be noted.

The action of cold may be intensified by pouring the water upon the body from a height, by causing it to fall upon the body with force as from a hose, or by showering it or spraying it on the body by the use of various arrangements of pipes &c.

The morning or early part of the day is the suitable time for such kinds of baths. Persons who are thus habituated to the use of cold water are less susceptible to the influence of cold and can stand longer exposure than others.

The Wet Sponge is the mildest method of using cold water, and is well adapted for the weak and delicate. The body may simply be

[1] This degree of temperature is of course unbearable unless the air is dry, and the explanation of its being borne is given on p. 735.

rapidly sponged over, or the person may stand or sit in a large shallow bath, and the water be squeezed from a sponge over the shoulders and body. This may be done in a warm room, the water in which the person stands being warmer than that from the sponge. After one application of the cold water, the person is quickly dried and dressed. At first the water in which the sponge is dipped should be tepid, and day after day may be used colder, as the person becomes accustomed to it, till quite cold water is used.

The Wet Towel is not quite so mild as the sponge. The towel is dipped in water of the desired degree of coldness, wrung lightly out and applied to the body, which is then vigorously rubbed with it.

The Wet Sheet is still less mild. The whole body is enveloped by the sheet, and rubbed up and down for several minutes. The wet sponge, wet towel, and wet sheet, may be used as stages in accustoming the body to the employment of cold water, preparatory to the trial of the ordinary cold bath; and the degree of coldness of the water and length of time of application can be regulated according to the effects produced.

Tepid Baths produce neither depression nor excitement, and are therefore suited for all. They are the best when prolonged immersion is desired, as in the treatment of chronic skin and nervous diseases.

The Warm Bath is particularly serviceable in removing feelings of fatigue. It should quicken only slightly the circulation, and bring an additional quantity of blood to the skin. It is by this means that it removes the tired feeling from exhausted muscles, for it promotes the removal from the tissues of the waste products, which have accumulated during the period of activity, whose presence in the muscles is the cause of the feeling of weariness. After prolonged labour, or a long fatiguing walk, or prolonged exposure to damp and cold, or after, for example, the exertion of much dancing, nothing is so restorative and refreshing as a warm bath. After such exertion many persons are restless, and desiring repose cannot find it owing to sheer weariness. A full warm bath, prolonged for fifteen or twenty minutes, will remove the ache from the muscles and substitute a feeling of quietness conducive to sleep. It is also capable of restoring the body to a condition in which renewed activity is possible with comfort. When employed for such purposes, the person should end with a spray or douche, or simple sponge of tepid water (70°) if he is about to go to bed, or with a warm spray, quickly reduced to cold, before dressing to go out.

Warm baths are largely employed in feverish affections of children, for promoting the action of the skin; and they are a safe resort in the convulsions of children, cold being at the same time applied to the head.

The Hot Bath acts in a more pronounced way upon the heart and nervous system than the merely warm bath. If very hot it powerfully excites the heart, whose action, indeed, it may stimulate to violence. The brain is also influenced by the more copious flow of blood through it, due to the vigorous action of the heart. These effects, however, are largely counterbalanced by the increased flow of blood to the skin. But the prolonged use of hot baths is weakening, and the temporary strain thrown upon the heart and blood-vessels and brain would be hurtful to many. The bather should be immersed to the chin; the hair is damped with cold water, and a thin cold cloth is wrapped about the head. Cold water may be drunk if desired. The bath should last twenty minutes, or less if oppression is felt. It should conclude, as directed for warm bath, with tepid douche or sponging, or with warm spray quickly reduced to cold. The hot bath should not be used in the morning or early part of the day, or at any time except before going to bed, unless the person is properly cooled down before dressing and going out.

Warm baths are valuable means of reducing excitement, and relaxing spasm, such as the temporary spasm causing inability to empty the bladder.

The Hot-air Bath is one of the most powerful ways of stimulating the activity of the skin. The person, unclothed, is placed in an apartment heated by means of furnaces, the air being dry. In a longer or shorter time, according to the heat of the air and the condition of the bather, the perspiration bursts out upon the skin, becoming very copious, so that the whole body is bathed in sweat. A very high temperature may be borne so long as the air is quite dry, for the sweat passes rapidly off from the body in the form of vapour, removing a large quantity of heat, and thus the temperature of the body does not rise, unless the air is very hot, when the heat of the body usually increases by two or three degrees. The same high temperature could not be borne if the air were moist, as in the case of a vapour bath, for then the air is saturated or nearly so with moisture and cannot take up more, or can take up very little.

In this case the sweat does not readily pass off from the body, and the regulating action of the skin on the heat of the body is interfered with. Marked oppression, difficulty of breathing, fulness in the head, faintness &c. would then speedily arise. When the air is quite dry, however, a high temperature, for example, that of 180° Fahr. can usually be endured with ease, and even above 212°. Not only the activity of the skin, but the action of the heart and of breathing are greatly increased. It is thus not suited for everyone, certainly not in its full form for anyone with weak heart or vessels, and for very full-blooded persons. The hot-air bath may also be given in a box heated with gas or spirit-lamps.

The Turkish Bath.—The hot-air bath is usually obtained with other accessories in the form of the Turkish bath. This bath was adopted by the Turks from the Romans, who derived it from the Greeks. The ordinary method, as used in this country, is well known, and the general arrangements need be but briefly mentioned. The bather enters the dressing-room (Roman *Vestiarium*) which is heated to an ordinarily comfortable temperature. Round the wall are stalls, curtained in front, and each provided with a couch. Beyond this room there are, in the fully-equipped Turkish baths, three rooms, separated from the dressing-room by well-padded doors. The first of these corresponds to the Roman *Tepidarium*, the warm room, in which the temperature is from 115° to 120°; beyond this and separated from it by heavy curtains is the hot room, or *Calidarium*, in which the temperature ranges from 120° to 140°; and still beyond is the hottest room, called also the flue room, corresponding to the Roman *Laconicum*. Here the temperature is not below 150°, usually 175° to 180°, but may be 200° and upwards. Every Turkish bath has certainly two rooms beyond the dressing-room, one in which the temperature may readily be raised to 140° or thereby, and one beyond it in which the highest temperatures may be obtained. The heating is accomplished by flues, beneath the flue-room, the other rooms being heated from it as well as by means of heated fresh air, admitted through appropriate openings. The flue from the furnace passes underneath the floor of the hottest room, and enters a coil of cast-iron pipes, coiling along three sides of the room, the walls of which are formed of glazed brickwork.

A most important point in the construction of a Turkish bath is the arrangement for ventilation. The great rapidity with which evaporation takes place from the body, subject to the high temperature of dry air, would speedily cause the atmosphere of the rooms to be impregnated with emanations from the skin, which would be inhaled by the bathers unless some very efficient means existed of removing the polluted air and substituting fresh warm air. This is of vital importance, and is necessary also for another reason, namely that the evaporation of sweat from the body renders the atmosphere moist. Now the air of the Turkish bath ought to be perfectly dry, and therefore the continual removal of moist and polluted air and its replacement by perfectly dry and pure hot air are necessary. This is now accomplished, in the best baths, by utilizing the draught in the exhaust flue of the furnace. The foul air is drawn *from the floor*, for it is near the floor the foul air collects, since it is less warm than the entering hot air, and is heavier by reason of the moisture and impurities it contains, and passing through pipes along the side of the bath reaches the chimney. Any arrangement which seeks to ventilate from the roof defeats its own ends, since the fresh hot air rises and will be drawn off, while the polluted air will be left.

In the warm rooms the bather reclines on a zigzag wooden chair, over which he spreads his dry bath-towel. In the hottest room the floors require strips of matting, or felt slippers are worn, to protect the feet. Wooden chairs are not admissible, on account of the great heat, and the best form of chair is one with canvas seat and back, which are easily cleaned by washing.

Convenient to the warm rooms is an apartment moderately heated and provided with low tables of marble, corresponding to the Roman *Lavatorium*. On one of these the bather lies down and is rubbed or shampooed by the bath attendant, soaped and scrubbed, and finally douched first with warm and afterwards with cold water, preparatory to a return to the dressing-room, as described later.

These being the general details of a Turkish-bath house, it will be well to describe the regular course of the bath itself; and we shall first of all describe the full bath as taken by anyone with whom time is no consideration, in a bath with three rooms of increasing heat.

The Full Bath.—The bather undresses in one of the curtained recesses of the dressing-room, girds a towel or similar contrivance round his loins, and carrying a bath-towel over the arm passes into the warm room. Here he stays only long enough to wet the hair with cold water, and perhaps drink of it, and then passes

on, straight through the hot room, into the hottest room. Spreading his towel over a chair he reclines upon it, talking little or not at all, wets his head with cold water, and drinks at his pleasure, but not too copiously, of cold water, which the attendant will bring him. Here he remains five or ten minutes. By this time the whole body will be bedewed with perspiration; and the bather passes out into the room next in temperature, the hot room, where he reclines for another ten or fifteen minutes. Then he passes to the warm room, lower in temperature than the former, and here he reclines till the attendant is ready for him, when he proceeds to the washing room. Here he lies on a table and the attendant goes over the whole body, rubbing the surface, and thus removing all loose effete skin, grasping and kneading muscles, bending joints and so on. He is then rubbed over with soap, scrubbed and washed down, and lastly douched with warm and then tepid and cold water. From this room the bather passes out quickly, plunges through a cold bath, and regains the dressing-room, where he is quickly dried down with warm dry towels. He is then enveloped in a dry bath-towel, and so attired he lies down on his couch in the dressing-room, covered over with a light rug or blanket, till his skin assumes its natural degree of warmth. Here the soothing influence of the bath proclaims itself, by the tendency to sleep which it induces, which should not be yielded to, however, because of its relaxing effect. When the skin is cool and dry, usually in fifteen or twenty minutes, the bather dresses quietly and deliberately. It is important that he should rest a sufficient time to be quite cooled down before he dresses, lest a second perspiration be induced as soon as he walks abroad, leading to a chill. At the same time he must not rest so long as to become chilly. Each bather should be able to determine by his own sensations, when is a suitable time to dress. Employed in such a way as has been described, the Turkish bath is not only unexcelled for its purifying effects, but is a wonderful restorative after fatigue, and imparts a delightful sense of lightness and buoyancy.

Now it may be pointed out that this order of taking the different rooms, the hottest first, and thereafter those of a lower temperature, is advised because a few minutes of the dry air of the hottest room will bring out the perspiration, as a rule, quickly, and will thus speedily relieve the strain on the heart and other organs. Once the perspiration is fully out it is easily kept up by a lower temperature, and hence the return to the room of lower temperature does not arrest it. On the other hand if one stays in the hot room till the perspiration is well out, and thence passes to the hottest room, a drying effect is apt to be produced. In the hot rooms the temperature of the body rises, one or two degrees, till the perspiration breaks out, by the evaporation of which it is prevented rising higher.

Taking the order of the bath as has been here given, many people entertain considerably divergent views as to the degree of heat that is desirable in the hottest or flue room, some being unsatisfied if 200° or even 212° is not reached, others seeking to have it about 175°, and others still lower. Concerning this point Dr. W. B. Hunter, of Matlock, makes the following remarks:—"It is no exaggeration to declare that the customary practice of a public bath has for its aim and ideal the endurance of the greatest possible temperature for the longest possible time. This is a truly simple ideal, and there is a certain simplicity likewise in those who strive after it. The result, on the contrary, is otherwise, and to such as are not gifted with an exceptional constitution and superabundance of vitality, the strain it involves brings much of mischief along with the benefits inherent to the bath. It entails in time an enfeeblement as marked as that invigoration which a more moderate use of the bath most surely affords.

"With the thermometer no higher than 103°, when one foot only from the floor level (at the customary height of five feet it was 115°), a copious perspiration was maintained for a period of forty minutes. The pulse meanwhile was soft, and never got above 84 beats per minute; the respiration was quiet and stood at 12½ per minute throughout, and the heat of the body, as observed by a clinical thermometer, kept close from beginning to end in the axilla (armpit) never got above 98·6°, an elevation no more than two-tenths of a degree beyond the normal. This should serve to show how little may be necessary, after all, for attaining to the full the principal object the bather has in view, and how slight need be the strain involved in its maintenance—an irreducible minimum, it might fairly be called. While recording these observations, note was made at the same time of the lot of a fellow experimenter who took his place in an adjoining room where the temperature registered as high as 156° though fixed but one foot above the floor level. The limits of physical endurance were reached with him in the space of twenty-five minutes only, whilst, with

no greater evidence of perspiration at any stage than was forthcoming at the modest temperature aforementioned, the pulse had gone up to 116, the respirations to 21, and the bodily heat to 103°. The palpitation, giddiness, and prostration, which thereupon compelled his retreat to the cooler chamber, subsided almost at once, and the pulse fell immediately to 102. Both experimenters were fairly representative, because habituated to the use of the Turkish bath; and subsequent observations were, in every point, confirmatory of this one. An extensive acquaintance with the bath in almost every variety of case and constitution has led the writer to adopt 135°, the thermometer standing at a level of 3 feet, as the maximum temperature proper for ordinary use in the average subject. From 115° to 120° is the temperature proper for the feebler order of patient, the hyper-sensitive also, and as the first or introductory bath for such as are not unmistakably robust, and free from the suspicion of anticipatory nervousness. For the regular *habitués* of public baths, on the other hand, an initial temperature of 170° is at worst but a harmless indulgence, provided it be not endured beyond the bounds of comfort, and is exchanged at once for a lower, as rational observation may suggest."

"That there are some who find themselves equal to encountering much higher temperatures than this, for a time, is not to be denied, but that such powers of endurance are exceptional, and the occasion for their exercise more exceptional still, is the teaching of experience to one whose opportunities of noting results have not been limited to a few cases, nor to the immediate occasion."

The ordinary duration of the full bath, from the flue room to the washing room, is from forty minutes to an hour. The time may be curtailed thus: flue room five minutes, hot room fifteen minutes, warm room ten minutes, and the remainder as directed.

Various modifications may be introduced. If the bath be taken only occasionally, the shampooing and soaping are desirable thoroughly to cleanse and stimulate the skin. If it be taken more frequently, as in a course of the baths, the shampooing and soaping may be dispensed with, except once or twice a week, and from the warm room one may pass to the washing room merely to be sluiced and douched. Again, after the washing, one may have a warm followed by a cold douche, and then pass straight to the dressing-room, without the cold plunge.

The full bath, however, though slightly modified in this way, is suited chiefly for those accustomed to it, and for the healthy and robust. For those, unaccustomed to it, a briefer form of bath is preferable as a preparation, for the first one or two occasions, and may be the only advisable form for those not quite robust.

The **Brief Turkish Bath** begins with the hot room, not the hottest or flue room, where the bather stays for ten minutes or thereby. The warm room is then entered for other ten minutes, and thereafter the bather proceeds to the washing room, ending as already described.

Many bathers never use the hottest room at all, remaining in the hot room twenty-five minutes or more or until profuse perspiration is excited, and passing through the remainder as described.

The **Mild Bath** consists in spending twenty to thirty minutes in the warm room only, thence the bather passes to the washing room. This is the form for the very old, the very young, and for invalids.

Some persons do not readily sweat in the warm room. If so they should not enter the very hot room. At first at least they should be content with the warm room, and after several trials the skin may be got to act more fully, when the very hot room may be borne. Difficulty in perspiring is held to be an indication for the need of the Turkish bath, rather than the reverse, an indication that the skin is not discharging its functions duly, and that this, the most powerful means of re-establishing it, will be followed by specially beneficial effects. When any real difficulty exists, an expert attendant is likely to be able to overcome it, if necessary by the use of a hot soaping bath for a day or two, or other means.

The Vapour Bath acts upon the body much as the hot-water bath does, but it acts more powerfully, though the effect of the heat is not so quick since vapour is a slower conductor of heat than water. This bath can, therefore, be borne hotter than a water bath, but the high temperature cannot be borne long, for the vapour does not permit of the loss of heat from the body as hot air does. The temperature of the vapour bath cannot be comfortably endured above 120° Fahr. The vapour bath is characteristic of the Russian baths. It is taken in a chamber filled with vapour, which is thus not only applied to the surface of the body but also inhaled. This makes it still more oppressive. It may be used, however, in a simple form, in which the vapour is not breathed, by the person sitting on a chair, inclosed within a box, an opening in the lid of

which permits the head being outside. This form of bath can readily be improvised anywhere. It is only necessary to seat the person naked on a chair, and surround him from the neck downwards by blankets, which envelop the chair also and hang to the ground. Under the chair is placed a shallow earthenware or metal dish, containing boiling water to the depth of 3 or 4 inches. Into the water are placed a couple of red-hot bricks. Or under the chair may be placed a spirit-lamp, supported above it being a shallow pan containing boiling water. A simple apparatus for such baths is in the market. Such baths are very useful for catarrh, for rheumatic and neuralgic pains, sciatica &c., as well as for cases where excessive action of the skin is desired to relieve deeper organs, for example the kidneys.—Ten to fifteen minutes are long enough for exposure in the vapour bath.

Sea-bathing.—Ordinary sea-bathing is of course cold, and produces the stimulating effects which have been described in the paragraphs devoted to the cold bath. There is besides the additional stimulus due to the salt, so that sea-bathing acts as an invigorating tonic. It is not, however, suited for everyone, and is taken much too indiscriminately. It is also indulged in without due precaution. It is a very common error for persons to remain in the sea too long. The townsman, as soon as he gets to the watering-place for his well-earned holiday, hastens to take a swim; and, if he is in company, thinks he ought to remain in the water as long as his companions, who, it may be, have been regular bathers for some time previously. He is somewhat disgusted on coming out to find himself shivering, and to notice the blueness of his skin, finds it difficult to get on and arrange his dress, because of stiff fingers, and cannot readily get up heat again, while his companions are glowing with warmth and vigour. He has stayed too long; depression has occurred and reaction is slow to set in. He may be giddy and threatened with headache, from excess of blood to the head. He is prone to conclude, or his companions to conclude for him, that sea-bathing does not suit him, and perhaps he is tempted to give it up. The proper course is for him next day to greatly shorten the length of his stay in the water. He ought simply to plunge in, come out quickly, and after a vigorous rub dress rapidly. Next day this may be repeated. If he finds reaction now readily sets in, he may prolong his bath by a minute the succeeding day, and thus gradually accustom his body to the bath, till he can equal his companions in the length of the bathe. Persons who are anæmic—that is, of deficient quality of blood—ought not to indulge in sea-bathing without advice, and failing advice had better try first a salt-water bath at home. Persons who have suffered from any internal complaint ought also to refrain.

The best time for sea-bathing is in the morning. It should never be indulged in immediately after a meal, when the business of digestion is going actively forward. Indigestion, cramp in the stomach, headache and so on are almost certain to ensue. If it be not taken before breakfast, a good time is before lunch or early dinner, for which the brisk walk home after the bathe will prove an excellent appetizer. Neither should sea-bathing be engaged in immediately after very active exercise when the body is in a state of very active perspiration or in a condition of fatigue. At the same time, moderate exercise before the bath is unobjectionable, and the body ought to be comfortably warm. The person should not wait till he has become perceptibly cool, but should undress quickly and plunge in bodily, wetting the whole body at once. Wading in to deep water is undesirable, the distribution of blood being upset by the cold water driving it upwards as one advances to deeper water. During the bath exercise should be active, as in continued swimming.

It should be remembered that children, because of the little-resisting power of their young bodies, are very readily depressed by sea-bathing, and are not to be subjected to it as a matter of course. By bathing at home, by wading, which they usually enjoy, they may be gradually accustomed to it; but they ought not to be forcibly immersed to their aversion and terror.

Sea baths may be imitated at home by the addition of common salt or sea salt to water. About 9 lbs. of salt to 30 gallons of water is a quantity commonly used. These are useful for children and specially for such as are of a scrofulous habit of body. For such sea-water is also used at home, after being warmed to any required degree.

River-bathing is less stimulating than sea-bathing because of the absence of the saline constituents of the water. The general rules applicable to sea-bathing are applicable to such fresh-water baths.

The benefits of open-air bathing—sea or river—are not limited, of course, to the action of the water but are increased by the action of the fresh air, the respiration of which is stimulated

by the bath, and by the active exercise in the open air invariably indulged in afterwards.

Medicated Baths.—There are many kinds of baths which have, or are supposed to have, special properties, valuable for diseased conditions, because of containing various saline substances dissolved in them. Such baths may be artificially prepared by the addition of the salts to the water, or natural mineral waters may be used for the purpose. Thus there is the **alkaline bath**, made by adding 6 ounces of crystallized carbonate of soda or 3 ounces of carbonate of potash to 25 or 30 gallons of water, a very useful bath in irritable diseases of the skin, such as itching, eczema &c. There is the **sulphur bath**, made by dissolving 4 to 8 ounces of sulphuret of potassium in 25 to 30 gallons of water, also useful in skin affections. **Pine baths** are made by adding some of the pine extract to the bath water. Extract made from the leaves of the pine is made and sold for this purpose, about a pound being the quantity added. A recent preparation—the extract of pumiline pine—is used for a similar purpose. They are employed in gouty and rheumatic cases and also for irritable conditions of the skin.

The **Mustard-bath** is made by adding a handful or more of mustard to the ordinary warm bath. It is seldom, however, used for a full bath, but is mainly employed as a foot-bath, for which one or two tea-spoonfuls of mustard are sufficient. The mustard foot-bath is a favourite and useful domestic method for warding off the effects of cold, combined with a hot drink and a warm bed. It is an exceedingly speedy method of withdrawing blood from other parts of the body. It will wonderfully relieve the throbbing headache of the congestive kind, and it may quite safely be used in the convulsions of children, their legs being dipped into it, and kept there till the skin is quite red.

It is not necessary to enumerate the various natural mineral waters, which are used for bathing purposes as well as for internal consumption. Some of them are considered in the sections devoted to drugs. It is only necessary to recall what has been said on p. 310 in reference to the very slight power possessed by the skin of absorbing substances. Any influence medicated baths are likely to have is not, therefore, due to the contained salts passing into the circulation, but to the temperature of the water, and the remote effects on nerves, heart, breathing &c. that, as already explained at the beginning of these paragraphs, may be so induced, and to the local effects on the skin, which will undoubtedly be influenced by the substances the waters contain in solution.

Mud-baths made of a muddy kind of earth found specially at Franzenbad in Bohemia, and used also at Carlsbad and Marienbad, also in Bohemia, are found useful in irritable conditions of skin, as well as in conditions of nervous excitement and in rheumatic affections. The earth is mixed with water from the mineral spring till it is throughout of a soft poultice-like consistence, a bath-tub is then filled with it, in which the patient sits, up to the neck, for about twenty minutes, after which the mud is removed by a clean water bath.

Various arrangements are employed for accentuating the effect of the water, whether used hot or cold, or for applying it to particular parts of the body.

The Douche is a jet of water directed upon some part of the body through a 1½-inch pipe, the force of the water, quantity discharged, and temperature being capable of modification. It at first lowers the vitality of the part to which it is applied, but reaction sets in quickly, so that its whole effect is stimulating, quickening tissue change. The douche may be used hot or cold, or one after the other in rapid succession, a change which is most stimulating of all. In old-standing complaints, thickenings about joints, for stiff joints &c. it is a very useful application. In the case of the descending douche, the pipe is 10 to 15 feet above the floor level, and for the horizontal douche the pipe is 4 feet above floor level. In the former case it is played first on the spine, and then shoulders, hips, arms and legs in succession. At the close it is directed on to the chest and head, the force of the water being broken by the hands. In the latter case the back, chest, arms, and legs are douched in the order named, while the patient rubs himself vigorously. Before beginning the head is wetted with cold water, and is douched last, the force of the water being broken.—The process should last from one to two minutes.

The Spray may be used hot (100° Fahr.) for half a minute, and then gradually becomes cold for two or three minutes, while the patient turns round, rubbing himself vigorously, the head getting its share. If used simply warm (90° Fahr.) and reduced to tepid (70° F.) slowly, it is milder. The **Rain-bath** is an overhead spray, and is used as described for the latter. The **Ascending Spray**, as a stimulant to the lower bowel, may be used cold for half a minute, or tepid for one or two minutes, or beginning

warm and becoming as hot as can be borne (105° to 120°) for two or three minutes, or hot and cold alternately, beginning warm (90°) gradually raised as hot as is bearable, then gradually reduced to cold, and raised again to be reduced once more, during a period of four minutes.

The Needle-bath is simply a fine shower-bath, arranged circularly so that the fine streams of water converge upon the body, the multitude of fine streams having a more stimulating effect than a simple dash of a mass of water would have.

The Sitz-bath or **Hip-bath** is a means of limiting the application of the water to the hips, buttocks and neighbouring parts. The form of the bathing-tub is such that the person has the bath in the sitting posture, the limbs and upper part of the body being out of the bath. When used as hot as can be borne, the bath is half filled with water at 100°. The patient sits down in it, on a hot flannel pad, another being placed on the back of the bath, the feet, outside of the sitz-bath, being immersed in a foot-bath of water at the same temperature. The patient is then enveloped in warm blankets from the neck, a thin cloth, wetted with cold water, being tightly wrapped round the head. After a few minutes, a pint or so of boiling water is poured slowly against the side of the bath, and this is continued from time to time till the water is as hot as can be borne (110° to 120°), sufficient water from the middle of the bath being removed to keep the level of water an inch below the bath brim. In twenty minutes the patient stands up and is sponged over with water at 80°. The cold sitz-bath should last only two or three minutes.

The sitz-bath, hot or cold according to circumstances, is in much use for abdominal and liver complaints, and specially for feminine ailments. Its soothing effects, when used hot, in painful and spasmodic disorders of bowels, bladder, and womb, are very marked.

The **Full Pack** is directed to be given as follows: On a bed or packing couch spread lengthwise three blankets, large and thick; and upon these a thin linen sheet wrung well out of cold water, its upper margin folded short of that of the blankets by half a foot or so. The patient lies down undressed on the sheet with arms close to sides, the head just beyond the upper margin of the sheet, the feet well within the lower, and so wrapped up in it quickly, one side after another, the neck and feet with special care. The blankets next, each in turn, are, side after side, tucked round about and beneath the body, smoothly and lightly, the spare blanket beyond the feet doubled back beneath. On the top of all put the bed-clothes, lightly pushing them under on each side, and lay the pillows, one lengthways on the body, the other across the legs, leaving the bolster alone beneath the head. Put a cold wet cloth round the head, a hot-water bottle to the feet, and give cold water to drink as desired. The window should then be opened—there being nothing in the case to the contrary—and sleep favoured. Let the patient remain thus for one hour. If the hot pack is given, the sheet is wrung out of boiling water, and kept coiled up till required.

This form of bath is a gentle but very efficient method of stimulating the skin and producing perspiration. It is in much use in feverish complaints, and is very valuable in "determining to the skin" in eruptive diseases like measles or scarlet fever. For calming excitement and restlessness, and inducing sleep it is also exceedingly useful; and it affords marked relief to the kidneys.

The Use of Baths in Disease.—The value of baths of various kinds in disease has been alluded to, by the way, in the preceding paragraphs. As an agent in the maintenance of health the bath is a necessity. As a means of restoring vigorous health to those who, without being the subjects of any actual disease, are yet "down" in general health, as the result of prolonged overwork, anxiety &c., it is an agent of great power. The stimulating and invigorating action of the cold bath has been sufficiently spoken of, and the soothing and sleep-persuading effects of judiciously-given warm baths have also been referred to. The treatment of actual diseased conditions by baths in association with rational treatment by medicines is an art requiring the knowledge and discretion of the skilled physician, applied to each particular case, and it is not, therefore, possible to state here rules, which can take the place of such active superintendence. It may be noted, however, that rheumatic and gouty disorders, chronic affections of the skin, digestive derangements, especially such as are associated with sluggish conditions of the abdominal organs (sluggish liver, constipation &c.), are among those in which the treatment by baths yields the most surprising and gratifying results.

In particular the Turkish bath, when administered not at random but under skilled superintendence, and in a degree suited to the strength and age of the person, is fitted to produce results far more effective than is generally

recognized. The reason is quite readily understood. These diseases are mainly those of bad general nutrition, dependent to a large extent on a bad quality of blood or to a bad distribution of blood. The free stimulation of the skin, which is produced, not only rids the blood directly of much effete material, which, in the case of gout and rheumatism, is at the bottom of the disorder, but also indirectly by the secondary effect on the other organs for removing waste, such as liver and kidneys. The improved condition of blood which results will profoundly affect every organ and tissue of the body. Similarly the redistribution of blood will relieve organs unduly charged with blood, and will induce a better supply to others which formerly enjoyed too little. Engorged conditions of liver and kidneys, catarrhal states of the air-passages, as in bronchitis, of the urinary passages, and of stomach and bowels, are markedly benefited by such changes. The effect of the withdrawal from the blood of the large quantity of water, which occurs during the exposure to the dry hot air of the bath, is found to be markedly beneficial in cases where there is an accumulation of fluid in some of the cavities of the body, as in the various forms of dropsy, while the absorbent system of vessels is also stimulated to the removal of the results of inflammatory swellings and thickenings. Nervous disorders, hysteria, neuralgia, nervous headache, sleeplessness, and so on, ought to be greatly influenced by a judicious use of such baths. Especially will this be so, if to the calming effect, produced by the withdrawal of blood from the central nervous organs to the skin, there be added the bracing and tonic effects of the spray, douche, &c., hot and cold, as may be appropriate to the case, combined with the powerful stimulus to improved nutrition which can be brought to bear by massage.

In particular it ought to be noted by anyone, to whom a Turkish bath is easily accessible, that it is of signal service in simple chills. At the outset of an ordinary cold, it will often prove an effective check, as well as to the ordinary stomach and liver disturbance, common to many as the result of cold.

While anyone may resort to the Turkish bath, at his own discretion, to ward off the effects of a suspected chill, or to cut short a simple cold, it should not be indiscriminately tried, it must again be said, for the graver disorders of lungs, kidneys, &c. For these cases competent advice and supervision should always be sought.

The value of the hot or cold bath, and similar substitutes for the Turkish bath, in eruptive fevers, has already been remarked on. On the Continent cold baths for the reduction of high temperature, specially in typhoid fever, are in extensive use.

Is the Turkish bath not weakening? is a question one hears very often put in a tone of voice that implies little doubt that it is so. If the explanations that have been offered as to the action of the bath have been understood, one will be prepared for the answer that, instead of being weakening, it is invigorating, *when properly employed.* If a man be weighed immediately after a Turkish bath, he will have lost weight undoubtedly, by the quantity of water and its dissolved salts, &c., and the amount of carbonic acid gas, &c., that have escaped from his skin and lungs—water and waste products, that is to say. The loss of water is easily made good, if that be necessary. The temporary loss of weight is a mere incident, however; the real and essential results are the quickened circulation, the redistribution of blood to the various parts of the body, the stimulation of various organs, and the sweeping out of the body of effete and hurtful materials. The results of these changes are speedily apparent in a feeling of freshness and lightness, and within a few days in increased appetite, because of improved digestion and absorption of food. This is the explanation of the fact that within a few days of commencing a course of baths, a person begins actually to add to his weight and to be aware of increased bodily vigour, provided appropriate food and exercise have reinforced the action of the bath. As a matter of fact repeated weighing is made use of in the best-conducted baths as an indication of the effects being produced. In cases of corpulence, of course, loss of weight is desired, but it is loss of weight by reduction of fat only, not by reduction of muscle. Indeed the corpulent patient needs not only to lose fat, but, as a rule, also to *build up* muscle. This process, also, the bath will aid, but, again, only when associated with proper dieting and exercise. In such cases it promotes the loss of weight in the same way that in others it promotes a gain of weight, namely by restoring the normal process of healthy nutrition, enfeebled in the latter class of cases and perverted in the former.

SECTION VI.—EXERCISE.

Effects of Exercise:
Effects of Exercise on Muscles;
Effects on the Heart and Circulation;
Effects on the Breathing;
Effects on the Digestive Organs, on the Skin and Kidneys;
Effects on the Nervous System.
Excessive and Defective Exercise.
Various Forms of Exercise:
Walking—The Expenditure of Energy involved in Walking and Climbing—Proper Daily Amount of Walking—Exercise for Girls and Children;
Running—Training for Running;
Jumping;
Rowing;
Lawn Tennis;
Bicycling and Tricycling;
Cricket, Football, and Golf;
Gymnastic Exercises:
Exercises without Apparatus—Exercises for arm, head, body, and leg, adapted for children;
Exercises with Dumb-bells, Bar-bells, and Hoops.
Exercises in the Treatment of Disease:
Massage.

Effects of Exercise.—We use the term exercise, as regards the body, to mean the use to which the various organs of the body are put. Thus we speak of exercising the voice, of exercising the brain, of exercising the faculty of reason, or judgment, or imagination, and we speak of exercising the muscles of the body as in walking, running, riding and so on. It is specially in the last sense that it is made use of in the following paragraphs, the use or employment of the muscles, voluntarily, in the various actions by which external work is done, as in walking, &c., the various kinds of manual labour, and in pastimes such as football, tennis, &c. In these exercises we put the various voluntary muscles of the body into action, and we shall best understand how profoundly such action affects the whole body if we consider how such action affects a muscle and what changes are promoted in it thereby.

The structure of voluntary muscle has been described in Pt. I. (Section III. A.), and its chemical constitution and properties have been indicated. We may recall the facts that a muscle consists of a number of fibres of living material in which chemical changes go on, that when the muscular substance is irritated it contracts or shortens itself, and that it may be irritated by a stimulus applied directly to the muscular substance itself, or by the stimulus given to it by the nerve in connection with it, the usual way in which muscle is caused to contract. While it is in a living state the muscular substance is always undergoing chemical changes. These changes are of the nature of oxidation or combustion, for by them oxygen disappears and carbonic acid gas is produced; that is to say, oxygen unites with substances in the muscle containing carbon, the union of the two substances causing the disappearance of oxygen and the appearance of carbonic acid gas. At the same time heat is produced, just as heat results from the union of the carbon of coal or wood with the oxygen of air in a grate (p. 527). When a muscle contracts, these changes are increased, a greater quantity of oxygen is used up, and a greater quantity of carbonic acid gas and heat is the result, and the more active the contraction of muscle is the greater is the increase in these changes. Moreover it has been shown that, as another result of contraction, more water is contained in muscle than is found in a state of rest. Water, we have seen, consists of hydrogen and oxygen, and the meaning of the increase in the quantity of water is that some substances, contained in the muscle, have been made to yield up hydrogen to combine with oxygen. In short, as a result of the activity of the muscle, certain complex chemical compounds have been broken down, and the carbon and oxygen they contained have united with oxygen to yield carbonic acid gas and water. As a result of this process of decomposition other chemical substances are formed, for after contraction the muscular substance is found to be acid, while at rest it is not so, and the acidity is due to the presence of an acid, called paralactic acid, and of free phosphoric acid. These facts are all indications that in an

actively contracting muscle chemical transformations are occurring, by which complex chemical bodies are broken down, of which carbonic acid gas, water, paralactic acid and other substances are the by-products or waste products. These changes can be shown to occur in a muscle separated from the body, in a muscle separated from the body of a newly-killed frog, for example, which can be made to contract for a very considerable time, after its removal, by stimulating with a current of electricity. It has been established by experiments, which it is not necessary to detail here, that such changes can go on not only at the expense of substances *contained in the muscle*, but also at the expense *of the muscular substance itself*. We, therefore, notice these two facts (1) that by exercise a breaking down of material stored up in the muscle and of the muscular tissue itself occurs, implying the necessity for the introduction of new material for repair, and (2) the formation of waste products occurs implying some arrangement for their removal. The fatigue of muscle, meaning a diminished power of contraction or, if excessive, temporary loss of power to contract longer, such, for example, as causes a person, who has taken a very long walk, to feel as if he could hardly move another step, and produces the tired, wearied, and aching sensation in his limbs, fatigue of muscle is due both to this consumption of material, not sufficiently counterbalanced by repair, and to the accumulation of waste products, which have been produced more quickly than they could be removed. It is probable that it is the accumulation of the waste products in particular that causes the tired sensations of fatigued muscles, and that rubbing of the limbs, the use of a hot bath, &c., greatly diminish these feelings because they help the speedy removal from the muscles of the waste substances. In ordinary circumstances material for the repair of wasted muscular substances is brought to the muscle, and the products of waste are removed, by the blood flowing through the muscle. Blood is brought to the muscle by the arteries which supply it, and it carries with it nourishing material for the rebuilding of the broken-down tissue and oxygen to replace that which has disappeared. The blood, after flowing through the muscle passes away by the veins, and it passes away poorer than it was when it came by the amount of nourishing material and of oxygen it has given up for repair, and less pure than when it arrived by the amount of carbonic acid gas and other waste products it carries off with it. This is shown by the fact that the blood—the venous blood—passing away from an active muscle is poorer in oxygen and contains more carbonic acid gas than the blood flowing to the muscle. Further, to meet the demand created by the activity of the muscle the circulation of the blood through it is more active than when it is in a state of rest, and, as another indication of the chemical changes going on, the heat of the blood is increased after its passage through the muscle.

If, instead of limiting our view to the results of the contraction of one muscle, we reflect what must be the consequences of the activity of a large number of muscles, as is necessary for walking, and still more pronounced in running, in cricketing, in boating, &c., we shall begin to realize how great must be the effect upon the whole body by the increased activity of the circulation induced, by the greatly increased demand for nutritive material for repair, by the call for more oxygen to effect the increased chemical changes, by the stimulation of the kidneys, lungs, and skin that subsequently results from the increased waste products thrown into the blood, which it is the business of these organs to remove, and we begin to perceive how it is that the exercise has a marked influence not only on the muscles called into play, but an immediate and stimulating effect upon every other organ of the body. As to the muscles themselves, the effects of exercise, always supposing it not to be excessive, are still greater than have been referred to. It is not only that substances in the muscle have been broken down and cast off, and that new substances have been built up to take their place. The stimulus to nutrition which the exercise has produced affects every part of the muscle, and not only those substances in it or of it, involved in the chemical changes. Every fibre of it shares in the benefits of the increased flow of the nutritious fluid through it, and increased size and vigour of the fibres, and, it may be, the production of new fibres, are directly encouraged. Not only does the movement of the muscle and the quickened flow of blood through it serve to remove the waste matters produced by the activity of the moment, but effete material, formerly produced, whose retention in the muscle has been encouraged by a period of comparative inaction, is now swept out. Thus the muscle is strengthened by the formation of new material in increased amount and reinvigorated by the cleansing process to which it is subjected. On the other hand, if for a season, more or less pro-

longed, little exercise is indulged in, the lessened activity of the muscles implies diminished circulation throughout them, and a falling off in muscular vigour and actual decrease in the bulk of the muscles, through wasting or atrophy. These are illustrations of these facts familiar to every one.

"The smith, a mighty man is he,
With large and sinewy hands;
And the muscles of his brawny arms
Are strong as iron bands."

The relation between the regular methodical use or exercise of his arms by the village blacksmith and the strength and firmness of the muscles is appreciated by every one. On the other hand most of us know that if the smith were, unfortunately, to have his arm broken, necessitating it being kept bandaged up and in a sling for six weeks or two months, at the end of that period, the muscles would be mere ghosts of their former selves, and could no longer wield the hammer on the ringing anvil with the energy or regularity or precision that formerly won the admiration of the village youth. This is a mere instance of the general law that regular and appropriate exercise of a muscle, as indeed of any organ of the body, strengthens it and renders it more fit for the performance of its duties, while want of exercise or insufficent exercise is attended by gradual and increasing weakness, and if long enough persisted in, incapacity for duty.

The effects of Exercise upon the Heart and Circulation are well marked. The force of the heart's beat is increased and its frequency also. This effect is well known to all of us. When exercise is excessive it is usually the violence and speed of the heart's action or its irregularity that warn us we are overdoing our powers, and whenever we become aware of such unpleasant action we ought to accept it as a sufficient indication that the exercise should now cease. But the quickening of the heart and of the circulation caused by moderate and judicious effort ought only to be pleasant and exhilarating, and to this effect indeed is due much of the pleasure which appropriate exertion affords. The benefits of such quickening are shared by every organ of the body. The immediate result is, doubtless, to supply the active muscles with increased quantity of nutritive material, wherewith the increased chemical changes may be satisfied, but the indirect results are to stimulate the activity of other organs, lungs, liver, kidneys, skin, among the number, so that the whole body is awakened to more active life.

The effects of Exercise upon the Breathing are very important. There is an enormous difference between the amount of oxygen taken into the body during a period of rest and during a period of work, and also between the quantity of carbonic acid gas expelled during the same periods. Thus it has been found that a man at rest will absorb 417 grains of oxygen per hour, but during exercise 1829½, four and a half times the amount, and that during rest he will give out 603 grains of carbonic acid, but during exercise for a similar period 2501. Pettenkofer and Voit showed that during a day of work 2639 more grains of oxygen were absorbed and 4392 more grains of carbonic acid gas were given off than during a day of rest. At the same time there is increase in the quantity of watery vapour given off. This implies increased flow of blood through the lungs, more frequent expansion, and more complete expansion, of the lungs; it also implies greater activity of the muscles of the chest by which the movements of respiration are effected, and increased strength thereby. The value of such effects on the healthy condition of the lungs cannot be overrated. It has been strikingly shown that wind-instrument players, and those whose occupation implies regular and methodical expansion of the lungs, are singularly free from lung affections, and this can only be due to the bracing effect of the steady use of the organs. Whereas those who have little exercise seldom have the chest well expanded or the lungs well dilated, and the lessened vital changes implied must as surely weaken the lungs, as little exercise of the arm will be followed by weak and ineffective muscles.

The effects of Exercise on the Digestive Organs are always beneficial, if the exercise is well-timed; and there are no organs which more speedily indicate the evil effects of too little. Exercise taken too soon after a meal, whatever form it may assume, is injurious, because it diverts the blood stream from the stomach and associated organs to the muscles, and slows or arrests the natural process. But exercise, taken some time after food, aids the process in its later stages, and promotes the absorption of the nutritive portion of the food, by the quickening of the circulation, as well as by the effect of the increased movements of the diaphragm, due to the increased rate of breathing, and by other movements to which the intestine is subject. The activity of the liver is notably affected in a double way. It is stimulated by the frequent concussions that result from the bodily activity, and the increased consumption of the energy-

yielding foods, fats, sugars, and starches, removes from it materials which, but for the call upon them, would be stored up in the liver for future use. Sluggish liver is one of the most immediate results of deficient exercise. It is a familiar fact that constipation of the bowels is almost certain to arise when exercise is not engaged in, and, in consequence, all the abdominal organs become loaded, and a sense of languor, of easy fatigue, a tendency to headache, and a feeling of general indisposition to exertion speedily result.

Exercise also influences the Kidneys and Skin. This it does not only by the increased flow of blood through them, but also by the increased demand made upon them to remove the waste which the exercise has caused. The quantity of water removed by the skin during exercise may amount to several pounds weight. The effect of exercise will not only be to cause the removal of waste products, the result of exertion, but also the removal of waste which might otherwise have remained, useless material burdening the bodily organs, but for this stimulus to their removal.

Of the influence of Exercise on the Nervous System Dr. Crichton Browne speaks strongly and with the voice of authority. He argues from the fact that the stimulus to muscular contraction is conveyed by motor nerves, the stimulus, in the case of voluntary movement, originating in a certain region of the brain, called the motor area, whose business it is to preside over muscular movements, and from the fact that the muscular movement stimulates sensory nerves, which convey the impression made upon them to other centres in the brain. The exercise of the muscles means, consequently, the exercise of nerves, of nerve-centres also, of part of the brain itself. The training by which a child acquires the ability to perform certain movements with rapidity, regularity, energy, and precision, is a training not of muscles only but of nerve-centres also, of the nerve-centres set apart to reign over these special muscles. The actions which stimulate the growth and development of certain muscles stimulate also the growth and development of certain associated parts of the nervous system. Just as a muscle or group of muscles will show weakness and also wasting if the movements, for whose performance they are designed, are not practised, so also will the associated nerve-centres fail to develop or waste—atrophy—for want of exercise of their corresponding muscles. Children can with ease acquire dexterity in the performance of certain movements, as for instance those of the fingers in the playing of a musical instrument, which can only with difficulty be learned in mature life and then never thoroughly, chiefly because in the mature years the nerve-centres, whose business it would have been to preside over the movements, are no longer capable of full development, because of prolonged neglect. "For the hand-controlling centre, if not fully exercised at its nascent (growing) period, can never afterwards attain to the highest cunning; witness the clumsy caligraphy of those who learn to write in mature life, even when they practise with more than boyish assiduity, and the inferiority of the work of any craftsman who has not served a regular apprenticeship to his trade." "A large district of the brain is made up, as we have seen, of motor centres, and is concerned in motor ideas, which form a no less essential part of our mental stores than sensory ideas. The growth of that district of brain is evidently to some extent dependent on muscular exercise, and if that is withheld at the growth period the development of that district is arrested. And not only so, but that district is made up of a series of centres in relation with different groups of muscles, and each centre is dependent for its development upon the activity of its own group of muscles, and the defective exercise of any group of muscles during the growth period in its own particular centre will result in dwarfing of that centre and a corresponding hiatus, or a general weakness must exist in the whole mental fabric. From this we might deduce that swaddling-bands so applied at birth as to restrain all muscular movements, and kept up during infancy and childhood, would result in idiocy—a speculation to which the wretched muscular development of most idiots and imbeciles, and the fact that their mental training is most successfully begun and carried on through muscular lessons, give some countenance. We should also have to infer that, in order to build up a sound and vigorous brain, we must ensure free exercise to the different groups of muscles in the order of the development of their centres, and must in no degree interfere with the natural sequence of their evolution." Thus exercise, "besides being essential to the maintenance of nerve-centres in health, has very special relations to their development and growth," and so it may be made to contribute to brain growth, and to the symmetrical development of the mental faculties. "We thus see that an extensive region of the brain, in which the motor centres are situated, and which is of course in intimate

communication with all the other regions of the brain, can only be fully vigorous when the whole muscular system is fully vigorous also; and we recognize that good muscle work is essential to good brain work."

In the sentences that have been quoted, Sir J. Crichton Browne is speaking of the relation between the stimulus to growth of muscles and stimulus to growth of the nervous system in the period of youth, when growth is possible. But this does not imply that good muscular work is possible alongside of good brain work at the period of maturity. Rather the reverse is the case. Good brain work implies active and increased circulation of blood through the brain, even as good muscle work requires increased flow of blood to the active muscles. As the quantity of blood in the body is limited, the blood cannot supply the muscles in increased quantity and also the brain at the same time. Within certain limits exercise, implying quickened circulation, will stimulate the nervous system as well as the muscular, but the limits are narrow. Thus many a man, concentrating his thoughts on some subject, and finding his train of ideas somewhat slow of motion, forsakes his desk and paces up and down his room, finding in the stimulus of movement quickened thought. But in such mild exercise his brain gets a larger share of the increased flow of blood than his muscles. It is a different thing when a person really exerts himself, really causes his muscles to engage in active vigorous work, for then the determination of blood to the muscles diminishes the supply to the central nervous organs. Thus two men, walking along a road together, engaged in conversation, indicate by the speed of their movement the earnestness or profundity of their talk. If the conversation is really engrossing their thoughts, if their arguments are becoming closely reasoned, if they are keenly discussing a question with one another, the chances are that their movement is suggestive of aimlessness and uncertainty, halts are frequent, and more and more prolonged, till at the crisis of the discussion, both halt and stand face to face to argue the thing out. On the other hand, if the two are walking against time, with the desire of covering a certain amount of ground in a given time, it is the conversation that becomes halting and soon ceases, only an occasional word passing between the two. How common is it for men, who cannot get to sleep because the brain, pushed to its utmost activity by the demands of business or of professional work, will not quiet down or stop its turmoil of speculation, or calculation, or imagination, how common is it for men in such circumstances to get out of bed and pace the floor, or dress and go out for a steady walk of a mile or two, till the blood is brought down from the head to supply the active muscles, and the nerve-cells cease from troubling. Energetic muscular effort is opposed, that is to say, to vigorous mental work *carried on at the same time*, except that amount of brain effort that is necessarily associated with the muscular activity, the effort of will and so on. This is well proved by the mental state of those who give themselves up, more or less exclusively to muscular work, to athletic exercises, &c. The habitual use of the muscles to an excessive degree "tends to starve the brain" as Dr. Browne puts it, "or some portions of it by detaining large quantities of blood in the muscles to the detriment of the brain, and by limiting cerebral activity to certain tracts, and leaving other tracts wholly uncultivated. Professional athletes, and men entirely given up to sports of any kind implying great muscular effort, are generally dull and stupid; and a distressing hebetude creeps over boys who are permitted to neglect school work and concentrate their energies in gymnastics." At the same time, when there is no excessive devotion to the muscular effort to the neglect of the mental exercise, but when both organs get their due share of attention and their due call to activity, there is no manner of doubt of the benefits which the brain, in common with other organs of the body, derives from the muscular activity.

Moreover, it has been pointed out that systematic muscular exercise, by the effort of will which it implies, the training which accompanies it more or less, and the definite ends which are set up for effort and attainment, have an important bearing on character through their influence on the nervous system. "A consciousness of increased power is acquired, and this in turn begets self-confidence, resolution, and courage—qualities which, if rightly directed by proper moral and intellectual training, elevate the tone of the entire character, and aid to an important degree in subduing the passions. Indeed, the more perfect control which the mind possesses over a vigorous than over a morbidly sensitive body is a matter of everyday observation, and has given rise to Rousseau's seeming paradox "the weaker the body the more it commands; the stronger it is the more it obeys."

Exercise then is not a mere matter of muscle. It is not a mere question of firm energetic muscles against small flabby ones: it is a matter

affecting the whole being, body and mind. It is a question of the vigour of the whole man, concerning the general well-being of the whole body, not an activity suitable for boys and young men, but necessary for both sexes and at all ages, a potent, nay an absolutely indispensable agent in the growth and development of the child, and as necessary for the continued health and active life of the fully grown as are food and air.

Excessive and Defective Exercise.

Excessive Exercise.—The benefits which have been described as resulting from exercise are so great that one is apt to think one cannot have too much of it. This is, of course, a mistake. The occurrence of fatigue is the immediate effect and indication of over-exertion, though one only of temporary occurrence. It implies that waste has been occurring with greater rapidity than its repair admits of, and that is not a normal occurrence of healthy activity. The heart experiences, in healthy states, no fatigue, because its periods of rest and of activity are so rhythmically alternated, and in such due proportion, that the upbuilding of the wasted tissue and the removal of the products of waste keep pace with the process by which the waste is produced. It appears that fatigue is due mainly to the accumulation in the muscle of waste products, and is also a sensation due to exhaustion of the nerve-centres, from which the stimulation to muscular contraction proceeded. Other temporary effects of excessive exercise are muscular pains, tremblings, cramp, &c., which rest speedily removes, and whose removal may be much aided by gentle friction with the dry hand and by the hot bath. But other and more or less permanent effects may arise from excessive exercise, which it is necessary specially to note. Changes of a degenerative kind may arise in the muscles concerned, and this is specially the case when the exercise affects small muscles or small groups of muscles. Thus writer's cramp, pianist's cramp, are illustrations, and similar illustrations are afforded by telegraph operators, violinists, type-setters, and others. A most instructive form is that known as Hammer Palsy, to which pen-blade forgers are liable. The explanation, as given by Dr. F. Smith, who has studied this form of paralysis specially, is as follows:—"The pen-blade forger uses a hammer about three pounds in weight. A pen-blade receives, in the process of forging and joining to the piece of iron by which it is attached to the haft, on an average, one hundred blows. The forger, if an industrious man, anxious perhaps to save, by working overtime, enough money to join a building society or to commence business on his own account, will work twelve or thirteen hours in a day. He will make as many as twenty-four dozen blades in a day, and in so doing will deliver twenty-eight thousand eight hundred (28,800) accurate strokes. The rapidity and accuracy with which these blows rain upon the slender piece of iron are wonderful to the onlooker. Supposing him to work three hundred days in the year, and to continue this for ten years, he will in that period have delivered eighty-eight million four hundred thousand (88,400,000) strokes, and just so many discharges of nerve force will have occurred in the motor ganglia which are engaged in the action, and in the higher ganglia which calculate the distance and judge of the amount of force necessary to be used." The paralysis that ensues affects specially the right hand.

There are, however, injurious effects produced by excessive exercise not limited to small numbers of muscles. Excessive exercise, as indicated in the paragraph relating to the effects of exercise on the nervous system, develops the muscular system to the detriment of the central nervous system. Apart from this negative result, positive evils arise, specially affecting the heart, lungs, and blood-vessels. If there is habitually excess of muscular activity, the constant state of increased activity to which the heart is stimulated leads to an overgrowth of the muscular tissue of the organ—to hypertrophy; and this produces an uncomfortable sense of the heart's beat, which, as a rule, ought to occur without much consciousness of it. One has the feeling of the heart thumping against the ribs, a feeling of which one is most readily conscious when one retires to bed, and which sometimes hinders sleep, and a feeling apt to be excited whenever anything occurs to worry or harrass one. Such a feeling may be sometimes due to mere irritability of the heart without any actual overgrowth. Another effect apt to be produced is that of dilatation of the heart—the walls of the heart yield to the excessive pressure of blood within them, and once any yielding has occurred it is more likely to proceed. The dilatation may be accompanied by overgrowth of a compensatory kind, so that the heart becomes greatly enlarged. Such a result is most likely to arise when the exercise necessitates severe strains being suddenly thrown upon the heart. Thus if a person tries to lift a very heavy weight, he takes a very deep breath, then fixes the muscles of the abdomen and the diaphragm, and, holding his

breath, puts out all his strength. The pressure this produces upon the heart by the way in which the blood is detained in it is very great. Such a strain is always thrown on the heart in long diving, in lifting or hurling heavy weights, in taking long or high jumps and so on. The pressure thrown upon the lungs by the deep breath and the holding of it is also very likely to cause stretching of the walls of the air-cells, and ultimately a loss of elasticity of the lung tissue, so that the walls do not return to their usual state, and what is called emphysema (p. 283) occurs, just as an overblown india-rubber balloon will have a permanent bulge in some part of its wall. Besides these results, the blood-vessels may suffer by the excessive pressure of the blood within them. Rupture of a vessel or bleeding may occur, or a crack of the inner wall of one of the larger blood-vessels or a bulge of part of the wall may be the beginning of aneurism.

Excessive exercise of groups of large muscles is likely to end in the production of disproportion and deformity, as in the unequal shoulders of the horseman, because of the special development of the rein-holding limb, or the lob-sidedness of the schoolboy who always carries his books on one side.

It is to be noted that so far as these results occur in those fond of running, jumping, rowing, diving, &c., they are the consequences of bad regulation of the exercise, are very often doubtless the result of strain without previous training or preparation. The evil effects of sudden strain on lungs or heart, quite unused to it, are clearly revealed in the cases of men beyond middle life, after a quick run for a car or a hurry for a train. In them not infrequently the heart refuses the effort, and collapse is the result. The effects of too much exercise are usually seen in young men and men in the prime of life, who are fond of athletic sports, and are keen at competitions. It is in these cases that the desire to excel needs restraint and the firm guidance of some one experienced in training. In young children effects of excess are not seen. They follow their instincts and rest when fatigue threatens, not pushing their efforts beyond a safe limit. Boys and girls about the age of puberty (p. 472), however, need careful restraint.

Defective Exercise.—The evils of insufficient exercise are more numerous than those of excess. The youth who has never had sufficient exercise never attains to fulness of growth and development. He remains stunted, soft, and puny, wanting in vigorous circulation, and the ruddy glow of health. He is unfit for prolonged effort at work or play. Weak-chested as well as weak-limbed, nervous and awkward, he is defective in nervous as well as in muscular activity; and good mental as well as good muscular work is impossible to him. Imperfect general nutrition and bad digestion are his portion. Girls suffer most frequently from such conditions, because healthy natural movement is too commonly denied them. In them bad development of the figure, lateral curvature of the spine, popularly called "growing out of the shoulder" is a frequent result. In adults a falling-off of general health and vigour, an unhealthy deposit of fat, weakened heart and circulation, are results to be expected. The children of such parents inherit feeble constitutions, and one generation passes on the inheritance to another, producing a puny race unable to withstand the strain and pressure of life.

It is now time to consider briefly the various forms in which exercise can be taken and the advantages of each, as well as any special rules applicable to each kind.

Various Forms of Exercise.

Walking.—There is no form of muscular activity which brings into full play all the benefits to the body that exercise can confer like that of walking. It calls into play the greatest number of muscles, leaving none outside the range of its influence we may say, except those of the upper extremities. The action of the muscles appropriate to it is regular and methodical, not sudden nor spasmodic. It implies no undue strain upon any organ, supposing of course that it is not unduly prolonged; and it is suited to all ages, except, of course, the very youngest. At the outset the muscles of the trunk are concerned in the maintenance of the erect posture; and the swaying movements of the body, produced by the weight of the body being carried now by one leg now by the other, imply the harmonious co-operation of many muscles to prevent overbalancing. All the muscles of the lower limbs, those from the hip to the trunk, those which straighten the leg and those which bend it, the muscles moving the ankle-joint and those acting on the toes, all have their regular alternation of contraction and of relaxation, as the body is pushed forward, as the weight is gradually moved from the right leg to the left, as the body gets the final push from the right leg acting through the ball of the toes, as the right leg is raised and swung forwards, pendulum-like, while the left leg kept straight now

alone supports the weight, and so on. One group of muscles contracts after another in rhythmical fashion with each stage in the forward movement, while others imperceptibly and yet effectually maintain the balance. The muscles of the head and neck, of the chest and abdomen all have their share, great or small, in the ordered movement. Now this movement so apparently simple and easy is exceedingly complicated, and implies the expenditure of a very large amount of energy. The Rev. Professor Haughton, M.D., calculates that a man walking along a level road at a rate of about three miles an hour expends an amount of energy which would raise a weight equal to $\frac{1}{20}$ that of his body through a height equal to the distance walked. Thus a man who in his clothes weighs 150 lbs. walks, let us say, one mile. A mile is 1760 yards or 5280 feet. The $\frac{1}{20}$ of 150 is $7\frac{1}{2}$ lbs. He expends therefore energy equal to that needful to lift a weight of $7\frac{1}{2}$ lbs. 5250 feet into the air, or 1 foot 39,375 feet, that is 39,375 foot-pounds, or $17\frac{1}{2}$ foot-tons in round numbers (17·67 exactly).

Thus a man 150 lbs.	in weight	walking	1 mile	expends energy	which would	lift	$17\frac{7}{10}$	tons one	foot high.
,,	,,	,,	2 miles	,,	,,	,,	$35\frac{1}{3}$	,,	,,
,,	,,	,,	5 ,,	,,	,,	,,	88	,,	,,
,,	,,	,,	10 ,,	,,	,,	,,	$176\frac{7}{10}$	,,	,,
,,	,,	,,	20 ,,	,,	,,	,,	$353\frac{4}{10}$	,,	,,

If the man carries a weight—a parcel, an umbrella, a bag—this ought to be taken into account. If he carries an overcoat, whether over his arm or on his back, it ought also to be counted. If his overcoat weighs 5 lbs. this extra weight means the expenditure during every mile of a quantity of energy sufficient to raise nearly $\frac{3}{5}$ths of a ton 1 foot, and in the 20-mile walk amounts to nearly 12 foot-tons. But this is the calculation only for a level road. If at the end of his mile he has ascended 50 feet, this would need to be added to the number of foot-pounds in calculating the energy. He has raised his body (150 lbs.) this height, however gradual the ascent may have been, and 7500 foot-pounds or $3\frac{1}{3}$ foot-tons would need to be added. Now, according to Dr. Parkes, 300 foot-tons is an average day's work for a strong healthy adult. We can, therefore, calculate what number of miles walked along a level road will be equal to a good day's work. A 20-mile daily walk would, therefore, be above the average. According to Parkes "an amount of work equal to 500 tons lifted a foot is an extremely hard day's work, which perhaps few men could continue to do. Four hundred tons lifted a foot is a hard day's work. Now, according to the table 353·4 foot-tons is the work done in a 20-mile walk, so that 300 foot-tons would be almost exactly 17 miles. This walk is then a fair day's work on a level road. There are conspicuous illustrations of this amount of work in walking being enormously overdone, but for only limited periods. Thus the amount of work done by Weston in his six-days' walking match has been calculated. On the first day no less than 1525·3 foot-tons were performed, that is, energy was expended in walking sufficient to raise 1525·3 tons one foot high; and on the sixth day the work done equalled $967\frac{1}{2}$ foot-tons. The total amount of work done in the six days was equal to 7026 foot-tons, making a daily average of 1171 foot-tons. De Chaumont mentions an illustration of a European weighing 160 lbs. walking 73 miles, which would equal 1378 foot-tons, but it was done in about 17 hours, and thus became really equal to about 2400 foot-tons. For the speed with which the work is done affects the result, or, as de Chaumont puts it, "there is a velocity at which the maximum amount of work can be done at the minimum of expenditure." This, I believe, is also true in the case of a steam-engine. A steam-vessel may be built with engines fitted to take her at a moderate rate of speed, say 11 or 12 miles an hour, at a certain cost, but if she is wanted to go much faster, say 20 miles an hour, the cost increases out of all proportion to the increase of speed, so that in the steam-engine there is also a velocity at which a maximum of work can be done at a minimum of cost. In walking the economical rate is three miles an hour. This is the rate into which one naturally drops, when adopting a comfortable easy gait, and it is the ordinary rate of the soldier's march.

These calculations have been made on the assumption that the work is done under favourable circumstances, that there is, for example, absence of all restraint from the muscles, so that they have full freedom to go through their movements in a way natural to them. This implies appropriate dress. If owing to the wearing of a long overcoat, for example, the natural movements of the legs have been restrained, the same distance covered in the same time would imply the expenditure of a large amount of more energy.

Any restriction of the breathing is specially

disadvantageous in walking. The increased need of oxygen, which the continually increased expenditure of energy implies, means quickened breathing, and any garment so made, or so tightly worn, that free play to the chest is not permitted, will seriously inconvenience the walker. All these disadvantages are seen to the full in women's dress as a rule, the long skirts, the tight corsets preventing free movement of the lower ribs, and the close neckerchiefs, all being opposed to the free play of muscles that is desirable. In men tightly-buttoned close-fitting coats and high collars are also undesirable. Then, further, if each individual is to be permitted to expend his energy in a manner most economical his walk must be one suited to himself; the length of his step must be fitted to his length of limb; and his attitude must be the one which is least irksome to him, and which restrains him least. Thus a tall man and a short man, walking together at the same speed over the same ground and keeping step, do not spend the same energy in the walk. We shall suppose that the tall man is thinner than the short one, and that in spite of their different heights the two are the same weight. If the short man tries to suit his step to the tall man's he expends a great deal more energy than is needful, and if the tall man restrains his movements to suit his companion he also is not economical of energy. The two should walk along each suiting himself, so that the tall man's steps will likely be longer but fewer than his companion's. This illustrates one of the difficulties of the soldier's march, in which all have to keep together. The restraint implied not only by this necessity, but by the stiff attitude, &c., leads to the march being slower, and makes the impossibility of covering more than 10 to 15 miles per day, unless for a brief period and with the troops lightly equipped.

If, again, owing to the form of the boots, the natural elasticity of the step were destroyed, the work would be more laboriously performed, or if owing to projecting toes, the foot has to be raised to a greater height, at each step, to keep it from scraping the ground. If the heel of the boot is too high or too low, an unnecessary strain is thrown upon the muscles, in the first case to keep the body from being overbalanced forwards, and in the second case the calf muscles are unduly taxed in lifting the heel and throwing the weight of the body forward from one leg to the other. A double-soled boot should have a heel an inch deep, and a single-soled boot a heel just over ½ inch deep. The boots should be wide-soled, the soles projecting beyond the "uppers," when the weight of the body is borne by them.

Then, as has been indicated, ascending a hill implies a great increase in the expenditure of energy, for one must consider that the total weight of the body is raised. How great the expenditure may be for an apparently little height is shown by the following table, which indicates the expenditure of energy by a person weighing 150 pounds mounting a stair, every step of which is 6 inches high:

A person 150 lbs.	in mounting	1 step	expends	energy equal to	75	foot-pounds.
,,	,,	,,	5 steps	,,	,,	375	,,
,,	,,	,,	6 ,,	,,	,,	450	,,
,,	,,	,,	10 ,,	,,	,,	750	,,
,,	,,	,,	12 ,,	,,	,,	900	,,
,,	,,	,,	20 ,,	,,	,,	1500	,,
,,	,,	,,	30 ,,	,,	,,	2250	,,

This last is equal to a little over 1 foot-ton (=2240 foot-pounds), and is equal to the body raised only 15 feet. Supposing this stair to be ascended 10 times a-day, the energy expended, merely in the ascent, would thus be equal to raise over 10 tons 1 foot high, and if the stair were ascended 17 times the energy expended would have been sufficient for a walk of one mile. The number of steps this implies is only 510 of 6 inches each. But there are 2100 walking steps in a mile, assuming each step to be the regulation military step, namely 30 inches, so that each step, in ascending a stair where the steps are 6 inches high, requires the expenditure of as much energy as $4\frac{1}{10}$ steps of the regulation length on a level road. That is to say it requires the same amount of energy to lift one's body 6 inches high in the air as to carry one's body 123 inches along a level road by walking, that is $10\frac{1}{3}$ feet. That is to say the expenditure of energy that will raise the body a direct height of 12 inches, that is 1 foot, will carry the body by walking $20\frac{1}{2}$ feet, or, in other words, a climb of 1 mile means the expenditure of as much energy as a 20-mile walk on a level road.

It is, therefore, plain how persons able to walk only short distances, slowly and with great effort, become at once aware of the slightest rise in the ground. The sudden need of a much greater expenditure of energy tells at once on

the heart and the breathing, and the person is quickly brought to a standstill.

The various considerations that have been stated enable one to form a rough estimate of the daily amount of walking exercise each one should engage in. Take the case of the business man, who takes the omnibus or car to his place of business, spends the most of his day at his desk and returns home in the evening, little disposed to move out again in the evening. In the case of the young man, his pallor, bad digestion, headaches, and general languor and feebleness may be the results of the little exercise, in the case of the middle-aged man, perhaps it is increasing stoutness, breathlessness, rheumatic or gouty tendencies that warn of the need of muscle work and fresh air. Both are ordered more exercise, but of what kind and how much, both are commonly left in doubt. On this point Dr. Parkes says, "we can perhaps say, as an approximation, that every healthy man ought, if possible, to take a daily amount of exercise in some way, which shall not be less than 150 tons lifted 1 foot. This amount is equivalent to a walk of about nine miles; but then, as there is much exertion taken in the ordinary business of life, this amount may be in many cases reduced. It is not possible to lay down rules to meet all cases; but probably every man with the above facts before him could fix the amount necessary for himself with tolerable accuracy."

As regards women a daily expenditure of energy to the amount stated could not be borne by them. That the habit of daily exercise is one of which they stand in most urgent need is not gainsaid by anyone. A man's business, as a rule, takes him out of door, and if the risk of his taking too little exercise for health is great, how much greater is it in the case of women, whose duties as a rule keep them indoors? Thus it is that for days together many of them are not outside at all; then they sally forth on a shopping expedition, spend many hours lingering about shop windows and hanging over shop counters, and then return home fatigued to the uttermost, requiring several more days at home before a further expedition is ventured on. This is a most injurious system, not only because of the many days without out-of-door exercise, but also because of the sudden exertion put forth for which the body is unfitted. Of course in attending to their household duties, they have exercise, but exercise wanting the freshening and invigorating influence of exercise in the open air. It is because of the warmer air of the house, and because of its deficiency in oxygen, that this kind of exercise is uniformly tiring and never invigorating. A daily walk, amounting altogether to four miles, ought to be insisted on, and would materially conduce to the health and comfort and liveliness of the women of the household.

Concerning children not much need be said. If they are left to their healthy instincts no artificial standards need be applied, or artificial methods used. For them no exercise can take the place of the play in which they naturally indulge, by which one may say every muscle and every sense are exercised in due amount. No school system of exercise can take the place of the exercise which they will themselves take, if they are allowed freedom of healthy activity. The decorous walk cannot meet their natural instincts. It is a false system of education which ignores this fact, and which seeks to force young children to repress their natural tendencies to romp by imposing a standard of manners and a sedateness of behaviour suitable enough, may be, for their elders, making up for it by some gymnastic device or "calisthenic exercises." For children let particular care be taken that their dress is not inconsistent with their natural freedom of movement. Too often a desire to have their children dressed according to the current fashion makes parents "impose a style of dress which forbids healthful activity. To please the eye, colours and fabrics are chosen totally unfit to bear that rough usage which unrestrained play involves; and then to prevent damage the unrestrained play is interdicted. 'Get up this moment; you will soil your clean frock,' is the mandate issued to some urchin creeping about on the floor. 'Come back; you will dirty your stockings,' calls out the governess to one of her charges, who has left the foot-path to scramble up a bank. Thus is the evil doubled. That they may come up to their mamma's standard of prettiness, and be admired by her visitors, children must have habiliments deficient in quantity and unfit in texture; and that these easily-damaged habiliments may be kept clean and uninjured, the restless activity so natural and needful for the young is restrained. The exercise which becomes doubly requisite when the clothing is insufficient, is cut short, lest it should deface the clothing. Would that the terrible cruelty of this system could be seen by those who maintain it! We do not hesitate to say that, through enfeebled health, defective energies, and consequent non-success in life, thousands are an-

nually doomed to unhappiness by this unscrupulous regard for appearances; even when they are not by early death literally sacrificed to the Moloch of maternal vanity."

I have quoted these remarks of Herbert Spencer regarding the exercise that ought to be freely permitted to the young of both sexes, and I cannot do better than also transcribe what he has said regarding the physical education of girls. "To the importance of bodily exercise," he says, "most people are in some degree awake . . . at any rate, in so far as boys are concerned. . . . Unfortunately the fact is quite otherwise with girls. . . . Why this astonishing difference? Is it that the constitution of a girl differs so entirely from that of a boy as not to need these active exercises? Is it that a girl has none of the promptings to vociferous play by which boys are impelled? Or is it that, while in boys these promptings are to be regarded as stimuli to a bodily activity without which there cannot be adequate development, to their sisters, nature has given them for no purpose whatever—unless it be for the vexation of schoolmistresses. Perhaps, however, we mistake the aim of those who train the gentler sex. We have a vague suspicion that to produce a robust physique is thought undesirable; that rude health and abundant vigour are considered somewhat plebeian; that a certain delicacy, a strength not competent to more than a mile or two's walk, an appetite fastidious and easily satisfied, joined with that timidity which commonly accompanies feebleness, are held more ladylike. We do not expect that any would distinctly avow this; but we fancy the governess-mind is haunted by an ideal young lady bearing not a little resemblance to this type. If so, it must be admitted that the established system is admirably calculated to realize this ideal. But to suppose that such is the ideal of the opposite sex is a profound mistake. That men are not commonly drawn towards masculine women, is doubtless true. That such relative weakness as asks the protection of superior strength is an element of attraction, we quite admit. But the difference thus responded to by the feelings of men, is the natural, pre-established difference, which will assert itself without artificial appliances. And when, by artificial appliances, the degree of this difference is increased, it becomes an element of repulsion, rather than of attraction.

"'Then girls should be allowed to run wild—to become as rude as boys, and grow up into romps and hoydens!' exclaims some defender of the proprieties. This, we presume, is the ever-present dread of schoolmistresses. It appears, on inquiry, that at 'Establishments for Young Ladies' noisy play like that daily indulged in by boys is a punishable offence; and we infer that it is forbidden lest unladylike habits should be formed. The fear is quite groundless, however. For if the sportive activity allowed to boys does not prevent them growing up into gentlemen; why should a like sportive activity prevent girls from growing up into ladies? Rough as may have been their playground frolics, youths who have left school do not indulge in leap-frog in the street, or marbles in the drawing-room. Abandoning their jackets, they abandon at the same time boyish games; and display an anxiety—often a ludicrous anxiety—to avoid whatever is not manly. If now, on arriving at the due age, this feeling of masculine dignity puts so efficient a restraint on the sports of boyhood, will not the feeling of feminine modesty, gradually strengthening as maturity is approached, put an efficient restraint on the like sports of girlhood? Have not women even a greater regard for appearances than men? and will there not consequently arise in them even a stronger check to whatever is rough or boisterous? How absurd is the supposition that the womanly instincts would not assert themselves but for the rigorous discipline of schoolmistresses!

"In this, as in other cases, to remedy the evils of one artificiality, another artificiality has been introduced. The natural, spontaneous exercise having been forbidden, and the bad consequences of no exercise having become conspicuous, there has been adopted a system of factitious exercise—gymnastics. That this is better than nothing we admit; but that it is an adequate substitute for play we deny. The defects are both positive and negative. In the first place, these formal muscular motions, necessarily less varied than those accompanying juvenile sports, do not secure so equable a distribution of action to all parts of the body; whence it results that the exertion, falling on special parts, produces fatigue sooner than it would else have done: to which, in passing, let us add, that, if constantly repeated, this exertion of special parts leads to a disproportionate development. Again the quantity of exercise thus taken will be deficient, not only in consequence of uneven distribution, but there will be a further deficiency in consequence of lack of interest. Even when not made repulsive, as they sometimes are, by assuming the shape of appointed lessons, these monoto-

nous movements are sure to become wearisome from the absence of amusement. Competition, it is true, serves as a stimulus; but it is not a lasting stimulus, like that enjoyment which accompanies varied play. The weightiest objection, however, still remains. Besides being inferior in respect of the *quantity* of muscular exertion which they secure, gymnastics are still more inferior in respect of the *quality*. This comparative want of enjoyment which we have named as a cause of early desistance from artificial exercises, is also a cause of inferiority in the effects they produce on the system. The common assumption that, so long as the amount of bodily action is the same, it matters not whether it be pleasurable or otherwise, is a grave mistake. An agreeable mental excitement has a highly invigorating influence. . . . Granting then, as we do, that formal exercises of the limbs are better than nothing—granting, further, that they may be used with advantage as supplementary aids, we yet contend that they can never serve in place of the exercises prompted by nature. For girls, as well as boys, the sportive activities, to which the instincts impel, are essential to bodily welfare. Whoever forbids them, forbids the divinely-appointed means to physical development."

Running is a form of exercise indulged in without harm by healthy children of both sexes, and useful for growth of muscles, expansion of the lungs, and stimulation to the heart. It is not, however, desirable at the period of most rapid growth, when boys are passing into manhood and girls into womanhood. When this period is passed in boys, is the time for training for running, namely between the years of twenty and thirty. After thirty running, especially in races, is not advised. The rate of expenditure of energy is in running enormously increased. The length of step is usually not much increased; it is the rapidity of the step that is affected. Thus in soldiers the number of steps per minute at "quick march" is 116, and at "the double" 166, the length of step being increased only from 30 to 33 inches, so that the distance covered rises from 187 feet per minute to 453, the latter being equal to a little over a mile in 11 minutes. It is this fact that makes the short man excel in short races, and the tall man in long-distance races. For the latter can increase his steps to a greater number per minute more easily, provided his utmost speed does not need to be very long maintained, while the tall man's most convenient pace will enable him to cover a longer distance at a good speed.

Training suited for such exercise is given, as follows, by Maclaren in his book on training: "With a man unaccustomed to running, I would say, let him begin with a mile; setting himself to cover the distance in about eight or nine minutes, at the easiest pace and make-believe race he can run in. Let him break from his walk to the ground into an easy trot, and practise it until he find his wind decidedly improved, and the work, such as it is, pleasurable. He may then do one of two things—either increase the distance by another half-mile, to be run at the same pace, or hold to the same course and cover the distance in one or two minutes less. When the mile can be run in six minutes as easily as it was run in eight, let the tactics be changed; let him break the uniformity of the run, and cultivate variety of pace; let him begin the race, as at first, at an easy trot; keep at it for a quarter of the distance to allow the organs of respiration and circulation to take up gradually the accelerated action which is demanded of them as soon as the trotting begins, allowing the muscles employed in locomotion to take up their accelerated action when the walking is relinquished; let the second quarter be in the same style, but at a somewhat quickened pace, still keeping within the margin of easy performance; and let the third, if the preceding causes no distress, be quicker still, gradually culminating towards its close to an effort at the utmost strain of the powers; and last, let it subside in the fourth quarter gradually into the first easy trot, ending in the effortless walk, to allow the throb of the heart and swell of the arteries and veins to subside and settle down, and the lungs to resume their peaceful tidal motion, and the air current in their cells its rhythmical ebb and flow. I do not give these as absolute, but as approximate distances and rates of speed; they must be in all cases proportioned to the powers of the individual; but whatever may be his powers, let him begin within them, and augment the work, very gradually, whether in velocity or distance; and this augmentation should always be regulated by the actual advancement made by the running powers, until at speed and without preliminary breath or preparation the distance prescribed can be run. The distressing and often incapacitating pain of shin-ache is owing entirely to a disregard of this principle of gradual preparation. It is but the same kind of discomfort, arising from the same cause, which men out of practice feel in the arms on rowing suddenly at speed; that is, unpreparedness in the parts to

perform the work suddenly put upon them." Diet suited for such training has already been indicated on p. 621.

Jumping implies a sudden great expenditure of energy. Thus it is calculated that a jump 2 feet high, made by a man weighing 154 lbs., is equal to an expenditure of energy which would raise 308 lbs. 1 foot high, and the highest jump on record 6 feet 2½ inches "is equivalent to the sudden raising of 956 lbs., or about ⅜ths of a ton, and hurling it into the air." The strain of such an effort falls on few muscles—those of the calf of the leg and front of the thigh. The great effort is sometimes not unattended by harm to the muscles involved or the bones to which they are attached. The muscles are sometimes torn across, and the bones may be snapped by the strong and sudden contraction of the muscles. The bones thus affected are usually the small bone of the foreleg—the fibula—and the patella or knee-pan, the latter of which is broken across by the pull of the straight muscle of the thigh—the rectus (see p. 74). Rupture may also be produced. Jumping of any extensive kind should not be engaged in without previous training, such as that for running, and the best age is said to be between the nineteenth and twenty-fifth years.

Riding is, next to walking, the most universally useful form of exercise. Pleasant to youth, it also has so much attraction for the elderly, that they enjoy the daily horse exercise when they could not be induced to walk. It is capable of so much modification, as regards the actual amount of effort put forth, that it may be suited to many for whom very active exercise is not desired. Thus though the horse may go at little more than a walking pace, and the rider may put forth practically no effort at all, yet he may be carried a considerable distance, so as to obtain to the full the exhilarating influence of fresh air without fatigue. Then even at such an easy gait, and with little exertion, the movements of the horse communicated to the rider produce very considerable stimulating effects upon the liver and other abdominal organs. It is, on this account, an invaluable form of exercise for men beyond the mid term of life, who lead sedentary lives, and who either will not or cannot put forth the energy, which a walk sufficient for purposes of health would imply. In the gentle canter they get the needed stimulus to the digestive organs without fatigue. It is this property of stimulating the abdominal organs by the rhythmical shocks, produced by the movement of riding, that makes exercise on horseback so peculiarly the kind of exercise for the dyspeptic. While thus capable of being made one of the gentlest kinds of exercise, it of course affords scope for much more vigorous effort. For women it is a very suitable kind of exercise, provided due discrimination be employed. Wherever the means of parents permit of it, children should be taught riding, although the daily riding lesson or canter ought never to be substituted for play or deemed sufficient exercise. Constant riding produces characteristic changes in certain parts of the body. Wasting of the muscles of the inner side of the thigh results from the continual over-exertion of these muscles in keeping the knees pressed against the horses' sides; and to this the awkward walking gait of ostlers is due. Then the marked disproportion in the use of the left hand and arm over the right, by holding the reins, occasions a prominence of the left shoulder particularly likely to be marked in girls and women. The remedy for these defects is to avoid making riding an exclusive form of exercise, and if children are allowed full scope for play and other forms of recreation, such as tennis, &c., they are not so likely to arise. It may be remarked that it is of very great importance to anyone who is to have frequent occasion to be on horseback that he should be suited to a horse. A short-limbed man on a broad-backed horse must suffer some distortion of the limbs, and if he is subject frequently to the improper position, it will undoubtedly leave its evidence permanently on the shape of his limbs. The reverse conditions would tend to make a man knock-kneed. "The men who show least deformity are those of a medium height, of about 5 feet 8 inches." The need of remembering this fact in the case of growing children, with their soft yielding bones, is apparent.

Rowing is, according to Maclaren, the chief of all our recreative exercises; no other can enter the lists against it. There is a difference, however, according to the same authority, between rowing as an exercise and rowing as an art for the object of sending a boat at the greatest speed through the water. In the latter case the boats are so constructed, they are so light, they offer so little resistance to the water, the "form" of stroke adopted is such, that "a boat-race has now become a matter of wind rather than of muscle," and, as an old waterman remarked to Maclaren at a university race, "The crew that can bucket it the fastest will win the race, *if they don't bu'st.*" Owing to the diminished resistance of the boat, way is not kept up

unless by short quick strokes, implying great strain upon the heart and lungs rather than great muscular exertion, so that it has become a question of "wind" rather than of muscle. On this account modern alterations in the directions noted "have advanced rowing as an art, but detracted from it as an exercise." Regarding rowing as thus practised, Maclaren says, it gives "employment to a large portion of the back, more to the loins and hips, and most of all to the legs; but it gives little to the arms, and that chiefly to the forearm (because of the actions of grasping and feathering the oar), and least of all to the chest. Moreover, as there is but *one* movement in rowing, namely, the stroke, indefinitely repeated with the most rigid precision, and as it is in the rearward half of this movement only that any real muscular effort is made or resistance encountered, it follows that every muscle of the body not employed in this action is excluded from the exercise; moreover, also, every muscle included in it is employed in but one line of action, while it is qualified and designed to act in many, and will be developed and strengthened in proportion as these manifold modes of its use are observed; and moreover, again, as, with few exceptions, all muscles have antagonistic muscles, designed to perform counter movements, it follows that as rowing consists of but one motion, the antagonistic muscles of those employed in executing this motion must be virtually unemployed. Thus, as I have said, the legs have strong employment in rowing, but it is the *extensor* muscles alone which have actual employment; the *flexors* are comparatively idle; they perform no exercise, they gain no bulk, they obtain no increase in power. They are excluded from the work, they have no share in the reward. . . . The part of the body which receives the smallest share of the exercise in rowing is the chest; it has little or no employment in the muscular effort required for the propulsion of the boat; and this is impressively evident in the results. Not only does it make no advance in development in this exercise, but, if it be exclusively practised, an absolutely depressing effect is exercised." Maclaren goes on to say that this result of falling off in growth of certain parts of the body by exclusive devotion to one exercise is common to any single exercise, and that some complementary exercise is required for developing these parts so neglected. For rowing he thinks the added exercise should be one which, while giving work to the muscles not employed in rowing, will in particular develop the respiratory capacity, for in rowing "respiratory power makes the first claim, and makes it more exactingly than in any other mode of physical exertion in which men can be engaged, not only on account of the rapidity of the inspirations and expirations, and not only from the fact that they are *not* regulated by the natural action of the lungs themselves, but by the artificial movements of the exercise, but also from the interruptions caused by the fixing of the chest, and forcibly holding in the lungs of the air inspired after, in the natural order of the function, it would have been expelled." The best auxiliary exercise in the case of rowing he thinks is running, when engaged in in a regular methodical way, as indicated on p. 754.

In ordinary rowing, however, rowing for pleasure, the pastime so almost universally engaged in during summer holidays on river or lake or at the sea-coast, the circumstances are very different. The build of the boats is different, and in every way there is much more resistance to be overcome, and, therefore, much more muscular effort put forth. Moreover the effort is put forth in a different manner, for the long swing of the back is very different both in its effects upon the muscles, and in its effects upon the heart and lungs, from the quick high-pressure stroke of the racer. The steady swinging stroke of moderate length, kept up, say by four persons, in a four-oared boat, which carries other persons as well as provisions, let us suppose, for the party going for a picnic by water, implies chiefly muscular effort, and no special strain upon the respiratory organs. In such rowing many groups of muscles receive exercise. No muscles are more exercised than those of the back, and those passing between the trunk and the lower limbs, both in the backward swing and the forward movement. For keeping up such exercise for any length of time, it is necessary that the breathing be accelerated little above the ordinary rate. A stroke of 20 to 25 can be well maintained, and will give good speed.

It is, then, really the latter circumstances that one must consider most, and for which one may state a few of the accepted rules. First of all, the clothing should be loose, tight nowhere. Women should specially note this condition. Stays ought, for such exercise at least, be laid aside. With them neither the muscles of the back get full play, nor does the breathing. For girls whose back muscles have had little opportunity of development, no exercise could be more recommended, provided it

be engaged in in a judicious way and not rushed at. The clothing should be of flannel material, and should be changed when the exercise is over. An extra coat or wrap of some kind should be at hand in the boat, to be put on if one stops rowing for a little. The breathing should not be restricted during the stroke; the breath should not be held, for that would imply holding the breath for a considerable time, then letting it go and taking in a new breath in a much shorter time than is usual. This implies a complete alteration in the natural rhythm of respiration, which leads to breathlessness and speedy fatigue. Indeed the quick onset of fatigue in the inexperienced rower is commonly, not the result of muscular effort, but the consequence of interference with breathing, and a deficiency of oxygen in the tissues. Let the breathing, then, be as natural as possible as to rhythm; accelerated slightly it will naturally be. Then the exercise is not to be engaged in without some regard for muscles unaccustomed to that form of activity. The youth whose only opportunity of such pastime is during the summer holiday, ought not to go at it his first day, as if he had been engaged in no other occupation all his life. Some restraint must be exercised; a little the first day at a quiet easy pace will prepare for a little more the second, and still more the third, till after several days more prolonged and vigorous effort may be indulged in with ease. The rower should stop whenever fatigue threatens; and he should never engage in the exertion till an hour or more after a full meal. Blisters are to be prevented by the handle of the oar being quite smooth, and being kept quite dry, by the hand being dry, sweat being removed (and to the same end dusting with white oxide of zinc powder is advised), and by never allowing the oar to slide in the hand, all "feathering" being executed from the wrist and elbow, chiefly from the wrist. If blisters threaten, "stop rowing for an hour, wash the hands well with soap and water, wipe the tender parts over with some vinegar, and then gently rub spirits of wine, or, if that is not available, whisky, gin, or brandy over the tender parts, drying the parts perfectly between each step of the process."

Lawn Tennis is one of the best of modern exercises, combining, as it does, an infinite variety of muscular effort, with a high degree of pleasurable excitement, and demanding and cultivating mental as well as physical alertness. It does not give mere exercise to the muscles, but it affords also a training in the art of constantly varying the quantity of energy expended to suit a particular purpose. It involves also some education in judging of distances, and the eyes receive no small part of the educational effect. One may say that it puts every muscle of the body into active exercise. Take the arm as an example; the muscles which bend as well as those which straighten it, the muscles which carry it away from the body, and those which carry it across the body, those which carry it high into the air, those which swing it backward and those which carry it forwards, are all in rapid succession called on for full activity. At one instant the forearm is rapidly twisted to deliver a backhanded blow, and at the next the action is as quickly reversed to take the return ball off the other side. Similarly every other part of the body has its work to do, as the player bends well forward to catch a low ball, now throws his body to one side now to the other, now bending well back, or jumping high in the air to stop a high ball, all the while his legs have to be on the alert to carry him wherever the vagaries of the game may demand his presence. It is a game in which anyone may take part, from the 8-year-old to his grandfather, a suitable partner only being necessary. It is a game in which women may hold their own with men, and meet them on nearly equal terms. Perhaps there is no game which will so rapidly impress women with the evils of fashionable dress.

No game involving vigorous exercise is without some kind of risk, and lawn tennis is no exception to the rule. The extreme rapidity and suddenness with which movements must be effected in every game, in which the players are even moderately expert, tend to produce sprains of tendons and tears of muscle. In particular, a tear of tendon or muscle is common in the neighbourhood of the elbow-joint, causing what is now called **tennis elbow**. It is either a tear of ligament over the head of the radius, the outer of the forearm bones, due to rapid turning of the hand palm-downwards, to deliver a backhanded stroke, or it is a tear of one of the muscles, by whose contraction the arm is recovered from this position. In each case the pain is below the elbow-joint on the outer side of the fore-arm. The treatment is complete rest from the game for the remainder of the season. The part should be gently rubbed upwards, and an elastic elbow-cap may be worn. Other muscles are apt to suffer in a similar way. The biceps is sometimes torn near its point of origin, at the inner and upper part of the arm

(see Fig. 67, p. 72), at which place a swelling immediately appears, and the arm drops. Rupture of the tendo Achillis (p. 75) may also happen, though it is not common, consequent upon the taking of a sudden forcible spring. Rest and rubbing, rubbing of the massage type are the remedies.

Bicycling and Tricycling.—This is a form of exercise which has grown immensely in popular favour of recent years. At first sight the muscular effort involved in driving the bicycle might seem greater than that required for the tricycle, because with the former machine the action of a great many antagonistic muscles is involved in maintaining the balance, but in reality the work done in driving the latter is much greater. It is quite true that the beginner speedily experiences a sense of fatigue, not restricted to the lower limbs, but general to the whole body, due to the strain in attempting to keep his balance. This is, however, because he has not acquired the art of nicely adjusting the action of the various muscles for the desired result. It is a misuse of his muscular effort, just as the child learning to walk expends a great deal of effort uselessly. The person who has acquired the art of sitting his machine is hardly conscious of the action of the various muscles which maintain the balance. On the bicycle the weight of the rider is partly supported by the saddle, and is partly made most effective use of in driving by being borne in the treadles, supposing, that is, that the height of the wheel is properly suited to his length of limb. It is, therefore, the muscles of the legs that are specially exercised, and in particular the extensors, which straighten the leg, and drive down the treadles, the way on the machine carrying the wheels round and diminishing the work to be done in lifting the legs. The arms, of course, also do effective work in guiding, the muscular tension involved in keeping the levers in the proper position involving steady effort, though an expert rider can so balance himself as greatly to diminish the strain upon the arms. On a level road, for example, the experienced rider can go a considerable way without his hands on the handle at all, so nice are the muscular adjustments which maintain the balance, but whenever any difficulty on the road occurs the muscles of the arms are at once and actively engaged. After a ride of long duration, the fact that a large number of the muscles of the body have been unconsciously engaged in the work is evident from the feeling of general fatigue, not fatigue limited to the legs or ankles or arms, but affecting also the loins and back. Now, on the tricycle the necessity of a fine adjustment of the body is not so needful, and certainly not so urgent, because the machine maintains its own balance. If the height of the saddle is properly adjusted, the rider is almost in the erect position and bears with a large proportion of his weight upon the treadles, but if his seat is somewhat low he will speedily become aware of the position of the most active muscles from the feeling of intense strain and weariedness in the muscles of the front of the thigh, the muscles which straighten the legs and thus drive down the treadles. In this case his weight is mainly borne on the seat and is largely lost as a means of propulsion. In the case of the tricycle, however, the extra weight of the machine, the increased friction from the number of wheels, and the diminished diameter of the wheels, necessitate a greater expenditure of energy for the same distance covered. Dr. James Cantlie thus calculates the expenditure of energy in the driving of the bicycle: "Take, for example, a bicycle with a wheel of 60 inches diameter, every stroke with the foot causes the wheel to travel half its circumference, or nearly 7½ feet, that is 90 inches. This is equivalent to three regulation walking steps of 30 inches; and not only so, but the impetus given to the bicycle by one stroke would carry it much further, whereas a step in walking gives no further 'way' on the body. Hence each stroke becomes lighter after the first, and less and less exertion is required to keep the machine in motion. From all these reasons, then, and from actual observation of the effect of comparative distances travelled, it is plain that to travel a mile on a bicycle is equivalent in muscular expenditure to about one-sixth of that expended in walking a like distance. The exertion spent in travelling a mile on the 'level' on a bicycle is not more than four foot-tons, so that, as 300 foot-tons is the calculated amount of daily exertion (see p. 751) necessary to expend to keep a man in health, an 80-mile ride can be undertaken by a man without danger of overdoing it. No road, however, is level or smooth; hence it is nearer the truth when the exertion expended is considered to be six foot-tons a mile; limiting the distance which ought to be travelled to less than 60 miles a day, if one is to keep within the bounds in regard to the energy expended. Of course, a healthy man can do much more than 300 foot-tons a day, but an exertion greatly over that amount cannot be continued

day after day without injury to the health." He calculates that 40 miles a day is about the maximum distance that ought to be attained on a tricycle, and at a rate of not more than six miles an hour.

When one considers the distance that can, after a little practice, be covered easily in an hour or two by even the tricycle, one perceives the value it possesses as a means of exercise. In half an hour one can be rid of the town and out in the open country, getting with the exercise the fresh air, perhaps not otherwise attainable, without risk and, after the initial cost of the machine, without expense. It is a suitable exercise for women as for men, for the elderly as for the young.

There is, however, great temptation to put on speed and to cover startling distances in the minimum of time. Any one who has seen a young man dismount from his bicycle with every vein of his face and head standing out, and with his face turgid with exertion, and purple from deficient respiration, does not need to be told that in this exercise, as in others, the pace may kill. The concentration of effort in the legs, for the attainment of speed, almost necessarily involves a fixing of the chest, as well as the strain put upon the arms to maintain a straight course by pressure on the handles. This means insufficient breathing, want of aeration of the blood, breathlessness, and so on. Beginners are apt by the vigour of their grasp to produce this fixing of the chest and speedy breathlessness, even when trying to go at no more than a moderate speed.

The vibrations communicated to the body by stimulating the abdominal organs are useful in certain sluggish states of the bowels, &c., such as may be a cause of indigestion, constipation, &c. But the bicycle should not be mounted by any suffering from heart or lung affections or with a tendency to rupture. They should have medical advice before using even a tricycle. The writer is not sure that a bicycle, or tricycle even, is a useful means of exercise for anyone suffering from marked disorder of the liver. It ought to be useful, by the stimulus it occasions, to slight sluggishness of liver, *if the exercise is taken in moderation and at a gentle speed*, but he is convinced he has seen it do much harm, in the case of a youth who was very fond of the machine and indulged in long rides, and was fond of making good records.

The dress should be of light woollen material, and well-fitting without being tight, that is the usual amplitude of garments is undesirable; a waterproof coat should be carried, and the cap should be of woollen material. Specially should the neck be free of constriction, and the loins, the knees also. Stockings should be kept in position by some other method, rather than by the tightness of knickerbockers, or anything of the garter kind. Ladies should wear light flannel garments, of no unnecessary length; and the objection to constriction applies to common articles of their dress which have already been objected to at sufficient length in this work (p. 472).

Cricket and Football vary very much in the amount of exercise they give to the body, which depends on the part the individual player must take in the game. The individual must merge himself in the body of men with whom he is associated. The game of cricket supplies all that an exercise should, work for the whole body, needing quickness of eye and alertness of judgment as well as good muscular development. For boys at school it is the most excellent of games, provided a boy plays with others of his own size and years, who will consequently bowl and hit with a strength to which he is equal. Its chief evil is the waiting about necessary before one has his turn at the wickets, during which the cricketer is not too careful to don an extra garment. In the game of football more risks are run than in any other. It calls for sudden efforts, to be followed by periods of waiting of longer or shorter duration. In consequence the pressure on heart and lungs is often very great, and the risks of lung affections from cold by no means small, not to speak of the frequency of accidental injury.

For both games a little training, of the kind which strengthens the organs of circulation and respiration, should be undertaken before the season begins. The best for this purpose is the training for running, which is given in detail on p. 754.

Golf, a Scotch game to begin with, is now rapidly becoming popular all over the United Kingdom. It is the perfection of an outdoor game. It implies walking at a steady even pace without hurry or excitement, abundant exercise, though not excessive, to the arms, an education to the eye in estimating distances, and a training in graduating the amount of force to be used to send the ball the needful distance, and the niceties of the game afford an educational influence of great variety and high order. It is a game enjoyed by both sexes, and at all ages; and one may say there is no disease, which does not prevent one wielding a club, in which it would be improper.

GYMNASTIC EXERCISES.

Gymnastic exercises are too often regarded from too narrow a point of view. Many people think of a gymnasium as a place where youths are put through a course of exercises to enable them to accomplish some particular feat, or to acquire some particular kind of dexterity. It is a place where one learns to fence, to leap, to turn somersaults and so on. This is not a correct view, though it is one unfortunately encouraged by the bad system pursued in many gymnasia, where the pupils are set to practise certain limited movements, the aim being to achieve a certain result in the length or height of a jump and so on. The result of any training, the chief end and object of which are the accomplishment of some feat or several feats, is that certain muscles of the pupil's body are developed to a great degree, while others are developed to a much less degree or are neglected. The consequence is a disproportion of parts, a want of harmonious growth and development of the whole body. It is commonly the lower limbs that suffer in this way, the upper part of the body being developed out of proportion to them. Now there is nothing in the term gymnastic restricting the kind of exercise. It is derived from the Greek, *gymnos*, naked, simply because the Greek stripped to his exercise; and the word does not, therefore, indicate the kind of exercise, but simply that the athlete removed all possible clothing so that there should be no hindrance to the full exercise of his whole body. Now the only aim, which gymnastic exercises should have, is the methodical training of all the muscles of the body for the purpose of promoting the highest possible development of all the powers and activities of the body, consistent with health. The object is not the accomplishment of a feat, which can be paraded on exhibition, but the perfecting of the physical framework of the body. As we have already pointed out such perfecting of the physical framework of the body, when not unduly pursued, is not without marked influence on the mental and moral sides of the individual. Such exercises then ought to be considered as essential parts of a good all-round education. Education, that is to say, ought not to be restricted to the intellectual powers. It ought to include the training of the body, and as a result one would have more frequent illustration of the "sound mind in a sound body" than is yet common. Gymnastic exercises ought to include every kind of muscular movement that is fitted to promote a harmonious development of the healthy body as a whole. They ought not to be looked at as the appropriate exercises for the production of athletes, but the necessary training for the production of healthy men *and women.*

It is to Peter Henry Ling, who was born at Smaland, in Sweden, in 1766, that we are indebted for a scientific system of bodily exercises. Student of theology, tutor, naval volunteer, and teacher of modern languages in turn, Ling, in 1806, became fencing master at the university gymnasium at Lund, Sweden, where he began to put in practise his views of a rational method of gymnastic exercise. Finally he was made a professor at Stockholm and director of a central establishment, founded for the practice of his system of movements, a system which was subsequently introduced into all the military academies of Sweden, town schools, universities, colleges, and even into orphan institutions and country schools. In the central institution the movements were also applied for the treatment of disease. Ling's idea was that "an harmonious organic development of the body, and of its powers and capabilities by exercise, considered in relation to the organic and intellectual faculties, ought to constitute an essential part in the general education of a people." He based his system of gymnastics on anatomy and physiology, each movement being designed for the exercise of a particular muscle or group of muscles, and the whole set of movements thus affording effective and appropriate work to all the various muscles, without unnecessary exertion or fatigue on the part of any. The design of such a system implies, therefore, a knowledge of the actions proper to each muscle or group of muscles, and the movements by which each can be brought into activity.

Nowadays, chiefly owing to the teaching of Ling and his pupils, methodical and graduated muscular exercises are employed both for the development of the healthy body and for the treatment of disordered states, such, for example, as spinal curvatures. In lateral spinal curvature, indeed, graduated muscular exercises afford almost the only suitable kind of treatment. There are many books now to be had, well illustrated, in which a great variety of exercises suitable for children and youths are well described, the performance of which is well fitted to develop the body in a healthy way. We shall give here only such exercises as might be made use of in any home, which require little or no apparatus, and which at the same time will put into action most of the muscles of the body.

EXERCISES WITHOUT APPARATUS.

If several persons are about to engage in the exercises, let them stand in line about 6 feet apart; let the instructor stand a little in front opposite the centre of the line. When he gives the word of command he should himself, at least at first, go through the movements, so that the pupils are aided in understanding their exact character.

The **position** in which each pupil should stand is that of **attention**, as it is called in the army. It is thus described:—The exact squareness of the shoulders and body to the front is the first and great principle of the position. The heels must be in line and closed. The knees should be straight, the toes turned out so that the feet may form an angle of 45°, the arms hanging easily from the shoulder, the hand open, the thumb to the front and close to the forefinger. The fingers should lightly touch the thigh, the hips being rather drawn back, and breast advanced, but without constraint. The body should be straight and inclining forwards, so that the weight of it may bear principally on the fore-part of the feet. The head is to be erect, but not thrown back, the chin being slightly drawn in, and the eyes looking straight to the front. This position is given in Fig. 297.


Fig. 297.


Fig. 298.

Stand at Ease is the next position to be taught. The arms are raised from the elbows, the right one as high as the right breast, with the palm directed to the left and to the front, the left one as high as the waist, with its palm upwards. During the movement the thumbs are separated from the forefingers, and throughout it the elbows are kept steadily pressing against the sides. This is the first part of the movement. At the next part the pupil strikes the palm of the right hand on that of the left, the arms are dropped to their full extent, the hands keeping together, and as they fall the right hand slips over the back of the left. At the same time the right foot is drawn back 6 inches, so that its instep is placed against the left heel. The weight of the body is supported on the right leg, the left knee being slightly bent (Fig. 298). In this position the whole attitude should be without constraint, the arms should hang loosely and easily, the fingers pointing towards the ground, the right thumb being lightly held between the thumb and palm of the left hand.

When the teacher has shown to each pupil the correct positions, he should exercise them in taking it together. Standing in front he gives the word of command, dividing the command into two halves, thus, *Stand at—Ease*, pausing for an instant after the first half, so that the children, knowing what is to come are all ready to act together when the second half is called out, in a quick, sharp tone. The first half is called, the **caution**, and is the signal to be ready. The orders are thus:—

Atten—(pause) *tion; Stand at*—(pause) *Ease.*

Those orders should be given several times, one after the other, say six or eight times, till the pupils get accustomed to assume the positions quickly *and all together.*

The caution is made a little longer, so that a little more warning is given, by the instructor calling out *Boys* (or *Girls* as the case may be) before giving the order, *Attention,* just as in army drill the officer precedes his order by the word *squad, company,* &c., according as he is addressing a squad or company.

First Arm Exercise.

Let the pupils stand in position of attention, and let them then be put through the following movements:—1. The arms are quickly bent at the elbow joint, the elbow being held well back and close to the side; the fingers are slightly bent, their points touching the shoulders. 2. The arms are rapidly raised and fully stretched above the head, the palms *being turned inwards.* 3. The arms, fully stretched out and without the least yielding at the elbow, are brought rapidly down, till they extend straight outwards in line with the shoulders, palms *downwards.* 4. The position of attention, the

position from which the movements began, is resumed.

The instructor, standing in front of the line of pupils, would conduct this exercise as follows, and by the following commands:—

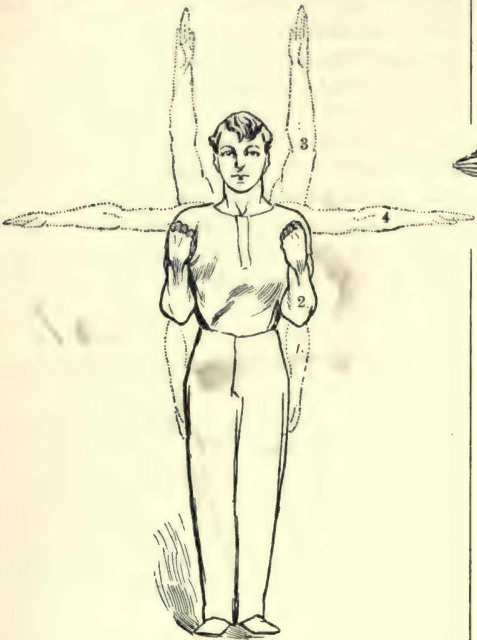


Fig. 299.

Boys (or *Girls*), *Atten—tion.*

For First Arm Exercise (this he calls out to let the pupils know what movements they are to execute).

Then, *One* (the pupils assume position 2 of Fig. 299).
Two (,, ,, ,, 3 ,, Fig. 299).
Three (,, ,, ,, 4 ,, Fig. 299).
Four (,, ,, ,, 1 ,, Fig. 299).

This exercise should be repeated eight times. End with the order *Stand at—Ease.* It may be varied by causing the pupils to perform it with one arm only. The instructor, in giving the caution *For First Arm Exercise,* would add—*with right* (or left) *arm only.*

Second Arm Exercise.

The pupils first get the command *atten—tion,* springing at once into the proper position. The movements they are now put through are as follows:—1. The arms are thrown straight up to their full height, as in 3 of Fig. 299. 2. The arms are stretched straight out in front, palms together, as in Fig. 300, the elbows being kept perfectly straight in executing the movement. 3. The arms are swung, fully stretched, to the back, and kept there, palms being struck together. This movement is a difficult one. The instructor must see that in this position the shoulders are straight, head well up, but chin drawn in, and eyes to the front (Fig. 301). 4. The arms are swung, fully extended, to the position of number 2, Fig. 300. 5. The first position, that of attention, is resumed.

Fig. 300.

Fig. 301.

The commands for this exercise are consequently as follows:—

Boys (or *Girls*), *Atten—tion.*

For Second Arm Exercise—

One (position shown as 3 of Fig. 299).
Two (,, ,, in Fig. 300).
Three (,, ,, ,, Fig. 301).
Four (,, ,, ,, Fig. 300).
Five (,, ,, ,, Fig. 297).

Repeat this exercise six times. End with the order—*Stand at—Ease.*

Third Arm Exercise.

From the position of attention the following movements are made:—1. The arms are swung, fully extended all the time, outwards and upwards till they are stretched, straight above the head, *palms to the front* (Fig. 302). 2. The arms are brought down, at the stretch, till they extend straight out in line from the shoulders, *palms upwards* (as in 4, Fig. 299, with the difference of the palms being upwards instead of downwards). 3. The upper arm being kept steady, the elbows are rapidly bent, and the fingers brought to touch the tips of the shoulders (Fig. 303). 4. The position of number 2 is resumed. 5. The arms are brought down to attention.

The commands for this exercise are:—

Boys (or *Girls*), *Atten—tion.*
For Third Arm Exercise—

One (see Fig. 302).
Two („ Fig. 299).
Three („ Fig. 303).
Four („ Fig. 299).
Five (the position of attention).

Repeat this exercise eight times. End with the order—*Stand at—Ease.*

Fig. 302.

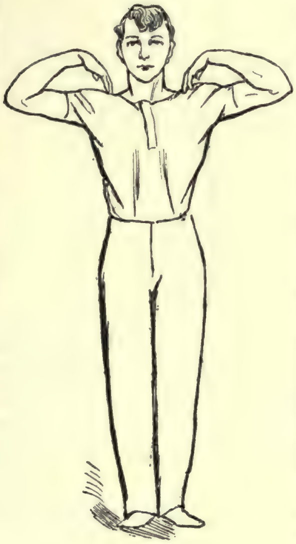


Fig. 303.

These exercises bring into activity the muscle which bends the forearm at the elbow—the biceps (see Fig. 67, p. 72), the muscle which straightens the arm—the triceps, the muscles which raise the arm, of which the deltoid and trapezius (p. 72) are the chief, the muscles of the back, which, acting from the spine, pull the arms backwards, the muscles which clothe the chest and carry the arms forwards, and the muscles which turn the hand into the prone and supine positions. But they do more: they act vigorously in expanding the chest. When the arms are strongly extended above the head, the ribs are raised, the cavity of the chest is enlarged and the lungs in consequence are more distended with air, and the vigorous pull on the shoulders by the backward movements of the arms has a similar effect.

While the pupils are being put through these exercises they must be cautioned against holding their breath. They ought to breathe freely and deeply all the time, never holding the breath at all. If the breath is held, and at first many will be found to do so, the pupil will be rapidly tired, simply from want of air. But if breathing is steadily and regularly maintained, fatigue will not quickly appear. Further the teacher must, at the beginning, be content with one exercise, repeated a few times. As progress is made several exercises may be gone through, one after the other.

When the pupils become accustomed to the movements, they must be caused to perform them with speed and energy. The arms must be extended, for example, with force, as if to hit something, and no matter how many children are in the line, the arms should shoot out, instantly at the word of command, as if from one body.

When the children have become acquainted with the exercises they may execute them to music, or, after they have been arranged in line and have assumed the "attention" position, they may, at a word from the instructor, proceed with them themselves without further command, the whole company acting together and chanting the numbers—*One—and two—and three—and four*—repeating the exercise over and over again till the instructor may call the halt. All this time the instructor simply watches the movements, seeing that all the children work together and keeping the whole line in order.

Head Exercise.

From the position of attention the following movements are made:—1. The hands are placed on the hips, fingers being in front and thumbs behind (Fig. 304). 2. The head is slowly bent backwards, the rest of the body being unmoved (Fig. 305). 3. The head is bent slowly forwards (Fig. 306). 4. The head is inclined to the right (Fig. 307). 5. The head is inclined to the left.

The commands would be given—
Boys (or *Girls*), *Atten—tion.*
For Head Exercise—One, &c.

This exercise should be repeated eight times. End with *Stand at—Ease.*

First Body Exercise.

From the position of attention, 1. Take the position shown in Fig. 308 by placing the hands on the hips and carrying the left foot 12 or 14 inches to the left. 2. Bend the body backwards as far as possible, the head being well thrown back and the knees kept stiff (Fig. 309). 3. Bend as far forwards as possible, the chest being well

out and head well back (Fig. 310). 4. Bend the body to the left (Fig. 311), and then to the right. 5. Resume the position of attention.

The commands are—

Boys (or *Girls*), *Atten—tion.*

For First Body Exercise—One, &c.

Repeat this exercise twelve times, and end with *Stand at—Ease.*

Fig. 304.

Fig. 305.

Fig. 306.

Fig. 307.

Second Body Exercise.

From the position of *attention* the following movements are to be performed:—1. Both arms are kept straight, the right is raised as high as possible above the head, *palm outwards*, and the left arm is stretched down, close to the side, as far as possible, shoulders being kept square to the front, back well hollowed so that the chest stands out, and the body well bent over to the

Fig. 308

Fig. 309.

Fig. 310.

Fig. 311.

left at the waist, the eyes looking to the right hand. 2. The right arm is brought down, and the left raised, the body being now bent over to the right, and the eyes turned to the left hand. 3. The left hand is now swung, *palm inwards*, sideways to the right, by a circular movement, and as it comes level with the right hand, both arms are raised high over the head, the backs

of the hands towards the face; the body is turned on the hips to the right and bent over to the left, the head being thrown back and the eyes looking to the backs of the hands. 4. Both arms are swung down by the front and up to the left, the body being turned to the left and

Fig. 312.

bent to the right (Fig. 312). 5. Resume the position of attention.

The commands for this exercise are—

Boys (*or Girls*), *Atten—tion.*

For First Body Exercise—One, &c.

Practise this exercise eight times, and end with *Stand at—Ease.*

Third Body Exercise.

From the position of attention, 1. Raise the arms as high as possible, palms outwards. 2. Bend quickly down and touch the ground in front of toes with the tips of the fingers, keeping the knees straight (Fig. 313). 3. Quickly straighten the body and then bend as far back as possible, the arms making a circular sweep till they are stretched beyond the head, palms outwards, the head being well thrown back and the eyes directed to the backs of the hands. 4. Straighten the body, and bring the arms to the position of attention.

Fig. 313.

The commands are—

Boys (*or Girls*), *Atten—tion.*

For Third Body Exercise—One, &c.

Practise this twelve times, and end with *Stand at—Ease.*

The special use of these exercises is to strengthen the great muscles passing up the back along each side of the spine (see p. 71), and the muscles passing between the trunk and the lower limbs, specially the psoas iliacus and glutei muscles, noted on p. 73.

First Leg Exercise.

From the position of attention, 1. Smartly raise the hands and place them on the hips, fingers to the front, thumbs to the rear, elbows and shoulders well forced back (Fig. 304). 2. Rise on the toes as high as possible, legs being kept straight (Fig. 314). 3. With the head erect and elbows well back, gradually lower the body, bending the knees, till the body just touches the heels, which latter must, as far as possible, be kept together, the knees being forced well apart (Fig. 315). 4. Raise the body, straightening the knees, without bringing the heels to the ground, and then lower the heels to the ground. 5. Resume the position of attention, the arms being dropped quickly to the side.

Fig. 314.

All the motions except 1 and 5 are to be performed slowly. In 2 and 3 the body must be kept upright.

The commands are—

Boys (*or Girls*), *Atten—tion.*

For First Leg Exercise—One, &c.

Repeat this twelve times, ending, as usual, with *Stand at—Ease.*

The second movement of this exercise brings into special activity the gastrocnemius muscle, which forms the calf of the leg and by whose contraction the heel is pulled up (see p. 74). Many other muscles are, of course, involved.

For instance, the knees are kept from yielding by the rectus muscle in front of the thigh (Plate II. 8 of fig. 3), while many muscles are concerned in keeping the balance. In the third movement the calf muscles are acting to keep

Fig. 315.

the heels off the ground, muscles in front of the thigh are acting to prevent sudden bending of the knee, and other muscles are on guard similarly at the hip, all this being done against the weight of the body, so that the work is considerable. In the fourth movement the straight muscle of the thigh acts strongly to straighten the leg and so on.

Second Leg Exercise.

From the position of attention, 1. Move the hands to a position behind the back, so that the left hand grasps the right arm just above the elbow, and the right hand supports the left arm under the elbow (Fig. 316). 2. Make a partial turn to the right, the right foot pointing to the right, and bring the back of the left heel against the inside of the right foot. The left foot should point straight to the front, and the right should be at right angles to it. The head should be erect, eyes directed to the front, shoulders pressed back and chest advanced (Fig. 317). 3. Take a full step to the front with the left foot, the right remaining flat on the ground. The right leg should be kept quite straight, the knee being well braced back, and the hips pressed forward. The left knee is bent, and is perpendicular to the instep. The body is kept upright and head erect (Fig. 318). 4. Bring the left foot back to the position of 2. 5. Face to the left, so that now the right foot points straight to the front, and the back of its heel is against the inside of the left foot. 6. Advance the right foot in the same way as the left was advanced. 7. Come back to the position of 5. 8. Resume the position of attention, from which the exercise started.

Fig. 316.

The commands will be understood from the orders given under previous exercises.

Fig. 317. Fig. 318.

Practise this movement twelve times, and end with *Stand at—Ease.*

Third Leg Exercise.

From the position of attention, 1. Make a full step to the left with the left foot, the right being kept flat to the ground, and the leg perfectly straight. 2. As soon as the left foot touches the ground, let the left hand grasp the thigh, just above the knee, thumb inside and fingers outside, the lower part of the left leg

and the left arm forming a straight line from the foot to the shoulder, the right arm remaining closely in line with the right leg (Fig. 319). 3. Turn on the heels so as to face the right,

Fig. 319.

and now make the left leg straight and let the left arm be stretched in line with it, and let the right leg and arm assume the position the left is seen to be in in the figure. 4. Return to attention in the original place.

Practise this twelve times, and end with *Stand at—Ease.*

Leg and Body and Arm Exercise.

From the position of attention, 1. Move the left foot 10 inches to the left and the right 10 inches to the right, heels being in line, toes pointing outwards, knees slightly bent, and arms hanging straight (Fig. 320)—the position of Fig. 308, but with the legs straight and the arms straight down in line with the legs. 2. Bend the knees till they project beyond the line of the toes, keeping the feet flat on the ground; at the same time bend from the waist and bring both hands to a position between the two feet, closed and placed against one another, knuckles touching the ground (Fig. 321). 3. Quickly straighten the back and legs, carry the arms close up by the sides till they are stretched above the head (Fig. 322). 4. Spring into position of attention.

Practise this sixteen times, ending with *Stand at—Ease.*

Such exercises as have been given in detail are useful only to a limited extent. They cause the various muscles involved to contract, but they give them little work to do. The only work the muscles perform is that of moving the part acted on against the resistance of its own weight. In bending the arm at the elbow, for example, the resistance is the weight of the forearm; in standing on tiptoe the resistance is the weight of the body. Now it has been found that, within certain limits, the more work a muscle has to do, the greater the resistance offered to its contraction, the better is the contraction, and the more valuable is the effect on the muscles themselves. While this is the case, it is not proper to put a heavy strain upon the muscles all at once, nor yet to tax them for a long time on end. The resistance should be small at first, and gradually increased till it reaches an amount, suited for the individual; and the exercise against this resistance should be continued for a short time to begin with, and the period gradually lengthened.

Fig. 320.

Fig. 321.

Fig. 322.

The weight of the body may be made use of to supply resistance for a few simple exercises. Thus let two chairs be placed about two feet apart; let the pupil, standing

between them, place one hand on each, and then step back, keeping the hands on the chairs till the arms are fully stretched; then gradually allow the arms to bend at the elbow till the body is lowered to the space between the chairs, the body being kept all the time rigid. The elbows should then be slowly straightened and the body raised. This is repeated several times. Or again, let the pupil stand between two supports, say school desks, two feet apart, one hand on each. Let him lift himself just off his feet by pressure through the arms, then bending his knees let him slowly lower himself till his knees touch the ground, and then slowly raise himself again. This he will not be able to accomplish all at once, but only gradually after repeated practice.

Dumb-bells are a simple means of giving the muscles work to do. Their weight should be in proportion to the capacity of the pupil, and can be increased in weight as the pupil's strength increases. For children it is recommended that they be made of wood, weighing for boys 1½ pounds each, for youths 2½ pounds. For adults they are made of iron and should be from 4 pounds upwards.

EXERCISES WITH DUMB-BELLS.

First Dumb-bell Exercise.

Let the pupils stand in a row in position of attention (Fig. 297), the bells together in front of the toes. Let the movements of the **First Arm Exercise** be then performed with the bells. At the command—*One*, the pupils bend the body, keeping the legs straight, and, seizing a bell in each hand, straighten the body, bending the elbows up to the position of 2 in Fig. 299, the bells being thus brought up to near the shoulder. At the command *Two*, the bells are raised above the head, the arms being fully stretched, and so on through the other movements of the First Arm Exercise.

The exercise should be repeated eight to twelve times, and, at the end, the command might be given *Down Bells*, at which the pupils would bend the body, keeping the legs straight, and having laid the bells down in front of the toes, would resume the position of attention. They could then get the order *Stand at—Ease.*

Second Dumb-bell Exercise.

This may be the **Second Arm Exercise**, performed with the bells in a way similar to the First Dumb-bell Exercise.

The teacher can thus take as a basis the exercises without apparatus and adapt them to movements with the bells.

The **Third Leg Exercise**, and the **Leg, Body and Arm Exercise** may be used for the bells as follows:

Third Dumb-bell Exercise.

The pupils stand in position of attention, the bells in front of the toes, and the following movements are performed: 1. Make a full step to the rear with the left foot, the right following. 2. Make a half turn to the right, and step to the front with the left foot, the left hand grasping the thigh above the knee, the knee being bent, the right leg being kept fully stretched, and the right arm in line with it as in Fig. 319. 3. Seize the right bell in the right

Fig. 323.

hand (Fig. 323) and raise it as high as possible above the head, the legs maintaining their position unchanged. The left arm is straightened, forming with the lower part of the left leg a straight line from foot to shoulder; and the hand presses firmly against the left knee, the breast being well pushed forward with the lifting of the bell (Fig. 324). 4. Replace the bell, the limbs keeping their position and then quickly spring back into position of attention.

This exercise is then repeated, from the other side, the body being turned to the left, the right foot stepping forward, and the bell being seized with the left hand.

Repeat this exercise from the right and left sides alternately sixteen times.

Fourth Dumb-bell Exercise.

From the position of attention, 1. The pupils take a full step to the rear with the left foot, the right following. 2. A half-turn to the right is taken, and then they step to the front with the left foot as in the last exercise; the body is bent over, the left knee yielding, the right leg being kept extended. Both hands pass down,

one on each side of the knee, each seizing a bell. 3. The bells are raised high above the head, the left knee being kept bent, and the right leg unmoved. 4. The bells are brought down and

Fig. 324.

Fig 325.

Fig. 326.

Fig. 327.

replaced in their original position. 5. The pupils spring back to attention.

This exercise is repeated, but the right foot is put forward, the body facing to the left.

Fifth Dumb-bell Exercise.

I. From the position of attention, 1. The pupils step to the rear as in the preceding exercise. 2. A partial turn to the right is taken, the right foot pointing to the right, the back of the left heel against the right instep as in the **Second Leg Exercise.** 3. They take a full step to the front with the left foot, the right remaining flat. The left knee is bent, the right leg is straight, and bending the body they seize the right bell with the right hand (Fig. 323). 4. The bell is raised high above the head and the body brought back to the position of 2 (Fig. 325). 5. They step again to the front with the left foot, lower the bell, and come back to the position of attention.

Fig. 328.

Fig. 329.

II. Repeat this exercise, the pupils turning to the left, putting the right foot forward, and lifting a bell with left hand, the movements being the same as those preceding, but the pupils acting from the left.

III. Repeat this exercise, advancing the left foot, but raising a bell with each hand (Fig. 326), stepping back with them into position of Fig. 327, stepping again to the front and lowering the bell, and lastly resuming the position of attention.

IV. Repeat the same exercise, advancing the right foot, and seizing a bell in each hand.

The teacher can easily distinguish the different parts of this exercise from one another. Thus his commands would run as follows:—

Boys (or *Girls*), *Atten—tion; For Fifth Dumb-bell Exercise; With one bell—from the right—One,* &c.

This would imply the first portion of the exercise; the second portion would be indicated by the caution—*from the left.* The third and

Fig. 330.

fourth portions would be indicated by the caution— *With two bells* and *from the right* (or *left*), as the case might be.

Fig. 332.

Sixth Dumb-bell Exercise.

This exercise is a repetition of the **Leg, Body, and Arm Exercise** (p. 767), but with the bells.

1. From the position of attention the position shown in Fig. 328 is assumed by the movements detailed on p. 767. 2. By the movements mentioned at the same place the bells are grasped, one in each hand (Fig. 329). 3. The bells are raised high above the head (Fig. 330). 4. The bells are lowered as in Fig. 329, and 5. The position of attention is resumed.

BAR-BELL EXERCISES.

The bar-bell is a rod of ash, 5 feet long, 1 inch

Fig. 331.

in diameter, and with a ball at each end. Exercises similar to those with the dumb-bell may be engaged in. Figs. 331, 332, and 333 illustrate

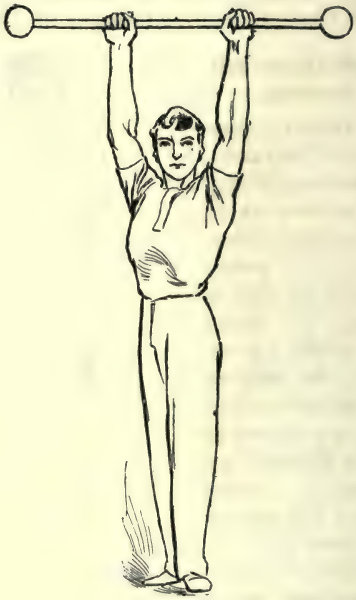


Fig. 333.

movements, the same as those of the **Third and Fourth Dumb-bell Exercises,** and the instructor can make use of other exercises which will readily suggest themselves.

Fig. 334.

Fig. 335.

Fig. 336.

HOOP EXERCISES.

For young children the hoop affords a variety of simple and useful exercises. The hoop should be light, 25 inches in diameter.

The teacher who has carefully studied the exercises without apparatus will be able easily to put together a few exercises, consisting of similar movements with the hoops in use, as the following figures show:—Figs. 334, 335, 336, 337, and 338.

Fig. 337.

Fig. 338.

The Use of Exercises in the Treatment of Disease: Massage.

Graduated Exercises in Disease. — The employment of exercises for the cure of disease, or what is called medical gymnastics, can, it appears, be traced back to the earliest times on record of the Hindoos and Chinese, and was in common use among the Greeks and Romans. Muscular pains and cramps, the results of muscular fatigue, neuralgias, spinal curvatures, were so treated, as well as dropsy and other diseases. In the beginning of the eighteenth century the methods, which had been long neglected, were

again brought into prominence by the publication of various works on the subject—one, in 1728, was by a London surgeon, Francis Fuller, called "Medicina Gymnastica"—but it remained for Ling to revive, or rather recreate the treatment, under the modern name of the "movement cure." Ling was led to believe in the possible benefit of muscular exercises by himself getting rid of a rheumatic affection of the arm by fencing. He set himself to study anatomy and physiology, and to investigate the value of definite movements on diseased states. In 1813 he first practised at Stockholm the curative movements. Of recent years, much more extended consideration has been given to the value of movements in disease, largely through the influence of pupils of Ling, and the applicability of such methods is now admitted in cases of rheumatism, neuralgia, sciatica, associated with another form of mechanical treatment called **massage**. Exercises, similar to those described on pp. 761 to 771, are employed, along with manipulations, by some one trained to their proper performance, of the kind described below, and along with what are called **passive movements**, that is movements of the patient's limbs, effected not by himself but by some person grasping the limb and causing the movement to be executed. Such treatment is found very useful, not only in the cases named, but also in sprains, inflammations of joints, stiffness of joints, in various nervous and digestive disorders, constipation, &c. In lateral curvature of the spine various simple exercises, without apparatus, are frequently sufficient to correct the deformity.

Massage is derived from the French *masser*, to knead, although kneading is only one of the manipulations employed in the process. It is not to be confounded with shampooing as practised by a bath attendant; and we are told that to acquire the art of properly giving a massage, implies much preliminary study and very prolonged and careful practice. The objects of massage are, in the first place, to influence the nutrition of the whole body, or a particular part of it, and, in the second place, to promote the removal of swellings, inflammatory products, &c., that disease may have occasioned in any particular place. It is comparatively easy to understand how these effects may be produced. When the masseur (*masseur* is the term applied to the male attendant who gives massage, *masseuse* to the female attendant), when the masseur rubs or strokes the skin, he immediately affects the circulation of blood through it. As his fingers pass over the skin, stroking it with some degree of firmness, he empties the blood-vessels, and when the pressure has passed the blood fills the vessels again with a rush. If he strokes always in the direction of the current, as he ought always to do—from the extremities towards the heart, never backwards and forwards in a random way—the assistance to the circulation is material. But he influences also the lymphatic vessels (p. 200), the vessels by which in particular the products of waste are removed, and he thus stimulates the removal of injurious substances. When he picks up the skin and rolls it, as it were, between finger and thumb, he does the same things more effectually. When he administers a brisk tap or slap with one or two fingers, or with the flat of the hand, the stimulus is again marked, for the skin immediately reddens. Then the masseur also ought to be acquainted with anatomy; he ought to be able to separate out with his fingers a single muscle or a small group of muscles, and treat them in a like way, through the skin, stroking them, squeezing them, kneading them, prodding them with the points of his fingers, or with the edge of his hand, and so stimulating the blood current to them, aiding and hastening the removal of waste from them, and exciting them to contraction. He ought to know the direction in which large vessels run, and the regions in which nerve trunks lie, and he ought to be able to insinuate his fingers between muscles to reach and act upon them also. All this is well fitted profoundly to affect the nutrition of the parts acted upon, and not them only, but also the rest of the body, through the circulation and the nervous system, and is very different from the few minutes' shampoo in the Turkish bath.

A variety of terms is used to indicate the kinds of manipulation employed, such as stroking, rubbing, kneading, pinching, pressing, squeezing, hacking. In some books the French words are used—*friction*, which explains itself, and *effleurage* both apply to the skin, the latter being the movement of rolling the skin between the fingers; *tapotement*, or tapping, and *petrissage*, or kneading, are the means by which deeper structures are reached.

General massage implies that the whole body is treated; partial massage means that it is restricted to some particular part. Half an hour to one hour is the time devoted each day to the process. The process should be performed on the naked skin by the bare hands of the operator, no oil being used; and the hands ought to be strong and firm, but soft, very considerable exertion being expended in the process.

The process is thus described by Dr. Weir Mitchell: "The patient lying in bed, the manipulator starts at the feet, and gently but firmly seizes the skin, rolling it lightly between his fingers, and going carefully over the whole foot; then the toes are bent and moved about in every direction, and next, with the thumb and fingers, the little muscles of the foot are kneaded more largely, and the interosseous groups (see p. 73) worked at with the finger-tips, between the bones. At last the whole tissues of the foot are seized with both hands and somewhat firmly rolled about. Next the ankles are dealt with in like fashion, all the crevices between the articulating bones being sought out and kneaded, while the joint is put in every possible position. The leg is next treated, first as to the skin, then by deeper grasping of the areolar tissue, and last by industrious and more profound pinching of the large muscular masses, which, for this purpose, are put in a position of the utmost relaxation. The grasp of the muscles should be firm, and for the large muscles of the calf and thigh both hands should act together, the masses of muscle being, as it were, twisted around the bone, while the hands alternately contract on them. In treating the firm muscles in front of the leg, the fingers or the two thumbs are made to roll the muscle under the cushions of the finger-tips. At brief intervals the manipulator seizes the limb in both hands, and lightly runs the grasp upwards, and then returns to kneading the muscles.

"The same process is carried on in every part of the body, and special care is given to the muscles of the loins and spine, while usually the face is not touched. The abdomen is first treated by pinching the skin, then by deeply grasping and rolling the muscular wall in the hands, and at last the entire belly is kneaded with the heel of the hand in a succession of rapid deep movements passing round in the direction of the colon (see Fig. 87, p. 131), while somewhat later the whole belly, relaxed by position, may be shaken by a rapid motion of the grasping hands. Pinching or squeezing of the skin is very valuable in certain spinal troubles connected with increased sensation, and in some other cases, if the surface and extremities be very cold; but the best masseuses often omit it, and rely solely upon the deeper grip and rolling of the muscles. The process should not be painful, or more at first than merely fatiguing; but after a time the muscles may be handled with a good deal of strength, without causing other than agreeable results. Too much care cannot be used to cover with stockings and warm wraps the parts after in turn they have been subjected to massage. As to time: at first the massage should last half an hour, but should be increased in a week to a full hour. Sometimes I use it twice a day, but commonly one hour suffices. Women who have a sensitive abdominal surface have, of course, to be handled with care, but in a few days a practised rubber will by degrees intrude on the tender regions, and will end by kneading them with all desirable force. The same remarks apply to the spine when it is hurt by a touch; and it is very rare indeed to find persons whose irritable spots cannot at last be rubbed and kneaded to their permanent profit. The daily massage is kept up through at least six weeks."

Massage has yielded its most remarkable results in cases of nervous disorder of a hysterical kind, in cases of wasting through imperfect nutrition, dependent upon some disturbance of stomach, bowels, or liver, and it has proved valuable in some of the special diseases of women, and in diabetes, while paralysed and contracted muscles are often wonderfully benefited by it.

SECTION VII.—CLIMATE AND HEALTH RESORTS.

Climate.

What is Climate?

Temperature as it affects Climate;
Temperature as modified by Elevation above Sea-level;
The Influence of Prevailing Winds;
The Effect of Position of Mountain Ranges;
The Influence of Ocean Currents;
The Meaning of Mean Temperature, &c.;
Moisture of Air as it affects Climate;
Rainfall.

Effects of Climate in Health:

Effects of Excessive Heat and Cold;
Effects of Humidity;
Winds and Atmospheric Pressure.

Effects of Climate in Disease:

Climate suited for Diseases of Lungs and Air Passages—Consumption, Bronchitis, and Asthma, and Climates suited for them;
Climates suited for Heart Affections;
Climates suitable in Diseases of Kidneys and other Abdominal Organs;
Climates suited for Malaria;
Climates for Nervous Diseases;
The Climates for Scrofula and General Diseases.

Health Resorts.

British Health Resorts:

The Isle of Wight, the Undercliff, Ventnor;
Bournemouth, Weymouth, Sidmouth, Exmouth;
Teignmouth, Torquay, Dawlish, Salcombe, Penzance, and Falmouth;
The Channel Islands; The Scilly Isles;
Brighton, Eastbourne, St. Leonard's, and Hastings;
Hythe, Sandgate, Folkestone, Dover, Ramsgate, and Margate;
Yarmouth, Lowestoft, Scarborough, Whitby, Redcar, Saltburn;
Bude, Barnstaple, Ilfracombe;
Aberystwith, Barmouth, Beaumaris, and Llandudno;
Southport, New Brighton, Blackpool, Isle of Man;
Rothesay and Bridge of Allan and other Scottish Resorts;
Queenstown, Glengariff, and other Irish Seaside Resorts.

Mediterranean Health Resorts:

The Western Riviera—San Remo, Mentone, Monaco, Nice, Cannes, Hyères, Genoa—Their Characteristics, and the Diseases for which their Climate is suitable;
Malaga, Ajaccio.

Other European Resorts:

Pau, Biarritz, Arcachon;
Coasts of Norway, Sweden, &c.;
Alpine Climates—Davos Platz, St. Moritz, Meran, Tarasp.

Atlantic Islands:

Madeira, The Canary or Fortunate Islands, The Azores.

African Health Resorts:

Algiers, Egypt, South Africa.

American Health Resorts:

California—San Diego, San José, &c.;
Florida; The Bahamas and Bermuda;
Colorado—Denver, Manitou Springs, Colorado Springs.

Indian Health Resorts:

The Hill Stations.

Australian Health Resorts:

Queensland (Brisbane), New South Wales (Sydney), Victoria (Melbourne), South Australia (Adelaide), Western Australia (Perth), Tasmania (Hobart Town), New Zealand (Auckland, Christchurch, Dunedin).

CLIMATE.

What is Climate?—The word climate is derived from the Greek, *clima*, a tract or region, and was applied to a portion of the earth included between two circles parallel to the equator. Different regions vary, according to their distance from the equator, in the amount of sun heat and light received, and in other attendant circumstances. Thus the word has come to imply, not the portion of the earth's surface itself, but its condition in relation to sunshine, temperature, character composition and moisture of the air, rainfall, wind, and similar circumstances, in their bearing upon life, and, in particular, human life. The climate of a place is determined principally by the duration of its exposure to the sun's rays, and this depends on its nearness to the equator. A large number of local conditions, however, operate as secondary, but, nevertheless, important factors in modifying this chief element and giving to a climate its distinguishing characters. The principal local conditions are the presence of mountain ranges, proximity to the sea, or, in inland districts, to rivers or lakes, height above sea-level, nature of the soil and vegetation, and so on. The chief of these factors in the production of climate we must give some little consideration to.

Temperature as it affects Climate.—It is the heat derived from the sun that determines the temperature of any place. The circumstances which directly affect the quantity of heat received from the sun by any place are the nearness of the earth to the sun and the direction in which the sun's rays fall upon the place. The latter is much more important than the former. In our mid-winter, owing to the elliptical orbit of the earth, the sun is distant from us more than 3,000,000 of miles *less* than in midsummer, and the lessened degree of heat at the former period, in spite of the increased nearness to the sun, is due to the oblique direction of the rays as they reach us, while in midsummer the rays fall more perpendicularly. Similarly it is at the period of the day when the sun is directly overhead that the greatest degree of heat is experienced. Now we have pointed out (p. 681) that the atmosphere is not directly heated by the sun's rays. The radiant heat from the sun passes through the air without perceptibly warming it, because the air does not absorb heat readily. This is very noticeable where the air is very clear and dry. Thus, on board a whaler, the rays falling on the deck have heated the pitch to the point of making it bubble out of the seams, while, in the shade, ice was forming on the ship's side. The rays falling upon the earth heat it, however, and heat it in proportion to its power of absorbing heat. The earth being heated will warm the layer of the atmosphere in contact with it, this layer becoming lighter by increase of heat will rise, and a cold layer will flow in to take its place, to be in turn warmed, and so on. The temperature of a place, while directly influenced by the exposure to the sun's rays and the direction in which these rays fall, is thus very powerfully influenced by the nature of the soil and its capacity for receiving and giving out heat, since it is only through this process that the atmosphere of the place is warmed. If the surface layer of the earth at the particular place is a good conductor of heat, the heat received by that layer will be conducted downwards into the earth for some distance, and to the extent to which the soil conducts well will the atmosphere have a less chance of becoming excessively warm, since air is a bad conductor. If, on the other hand, the soil is of badly conducting material, the heat will not readily pass downwards, and the atmosphere will receive more heat from the soil. Rocky surfaces conduct well, so also do clay and loamy soils, and the heat does not, therefore, accumulate so much on the surface of such soils. Sand, on the other hand, is a bad conductor of heat, and during exposure to the sun's rays becomes excessively warm. It also has a very high absorbing power for heat, absorbing nearly double the amount of heat that earth (mould) will. Consequently, owing to both these circumstances, the atmosphere over sandy deserts becomes oppressively hot, "the surface temperature of sandy deserts of the tropics rising frequently to 120°, 140°, and more rarely 200°." Moreover, the amount and nature of the vegetation of the district will have a modifying influence on the temperature, for vegetation will protect the soil from the sun's rays to some extent, and by evaporation from leaves, &c., will prevent the temperature of the surface rising so high as it would otherwise do. In a climate of a country covered with vegetation one does not, therefore, find the same extensive variation of temperature within twenty-four hours as is found in a country without vegetation, the vegetation keeping the district cooler during the hottest part of the day than it would otherwise be.

Now during the time that the sun's rays are

being poured upon a district, the temperature of the surface layers of the earth is rising, because they are receiving more heat than they are giving out. They are, however, giving out heat to the atmosphere in contact with them, whose temperature is rising also. But when the sun has set, and sometime before then, the earth is receiving little heat and is giving out much, its temperature is therefore falling. During the sunny parts of the day, that is to say, the earth is storing heat, and during the sunless parts of the twenty-four hours it is distributing it. If a great deal is stored and slowly given out there will not be marked extremes of temperature in twenty-four hours, very hot by day and becoming suddenly cold by night, but the heat will be more evenly distributed during the twenty-four hours and a more equable climate will result. As an illustration of this we have already instanced the effects of vegetation. Forests have a very striking effect of this kind. "Trees are heated and cooled by solar and nocturnal radiation in the same manner as other bodies. They do not, however, acquire their maximum temperature till a little after sunset. This occurs in summer at 9 p.m., while in the air the maximum temperature occurs between 2 and 3 p.m. Hence trees may be conceived as reservoirs in which the heat of the day is stored up against the cold of the night. Changes of temperature take place very slowly in the tree, but in the air they are very rapid. Hence the effect of forests on the daily temperature is to make the nights warmer and the days colder, or to give to the climate of countries clad with trees something of the character of an insular climate" (Buchan). Another excellent illustration of the same thing is the modifying influence of large masses of water. Water, it has already been pointed out, has a greater capacity for heat than any other substance. The same quantity of heat will not raise its temperature so high as it will that of other substances. Moreover radiant heat from the sun can penetrate to some depth into water, and thus the ocean, inland lakes, &c., can receive enormous quantities of heat, without their temperature being raised nearly to the same extent as land receiving equal quantities. These circumstances produce most marked modifying effects on the climate of localities by the sea, lake, or river. The surface of the sea being never heated by the sun's rays to the same extent as the surface of the land bordering it, the atmosphere in contact with the sea will be cooler than that in contact with the land, and thus a current will be established from sea to land—a sea breeze—which will keep the land cool. In the evening the land cools down much more rapidly than the sea, for the surface of the sea cannot, like the surface of the land, cool down more quickly than its deeper layers. As soon as the surface layer becomes cool it sinks, and is replaced by warmer water rising. The atmosphere over the land will, in consequence, become speedily colder than that over the sea, so that a land breeze will be created. In this case the warmer air from the sea will prevent the too rapid cooling of the general atmosphere. Thus during the day the climate will be less hot and during the night less cold than it would be, but for the modifying influences of the sea. Inland lakes have a similar effect though not nearly so marked, but when they are frozen over the influence ceases. In such circumstances as these, there is a period of the afternoon when the sea breeze begins to die down, because, owing to the setting sun, the land is less warmed and its air becomes more nearly like that of the sea in temperature. Between that period and the commencement of the land breeze, perhaps two or three hours later, when the earth has cooled sufficiently, there is a period of calm; and there is similarly a calm in the morning between the dying down of the land breeze and the setting in of that from the sea.

In another way does the presence of large masses of water influence the climate of a place. Wherever there is much water the air must contain a considerable degree of moisture because of evaporation from the surface, another agent in keeping down the temperature. Now while perfectly dry air will not absorb the solar rays as they pass through it—is transparent to heat, or diathermanous, as the correct word is—watery vapour does absorb heat to some extent. Moist air does, therefore, become warmer by the sun's rays passing through it, dry air does not. Moreover, when the heat is being given off from the earth at night, it will pass off much more rapidly if the air is dry and clear than if it is moist. There will, therefore, be less rapid cooling of the air at night in a locality where the air is moist to a greater or less degree. A moist atmosphere is heated to some degree not only by the sun's rays passing through it, but also to a considerable extent by rays reflected back into the atmosphere from the earth, for the earth does not retain or absorb all the rays that fall upon it. Now if the air were perfectly dry, these reflected rays would pass through the atmosphere without warming

it, but when the air contains watery vapour, the watery particles absorb the reflected heat and thus retain, in the neighbourhood of the ground, heat, which would otherwise have been dissipated into space. The presence of clouds in the sky diminishes the loss of heat at night by radiating back to the earth the heat given off by it, and the lower the clouds are the more effective are they in maintaining the heat. It is this which explains the sultry oppressive feeling of the atmosphere on the evening of a hot summer day when the sky is dull.

Elevation above the Sea-level has a striking effect on the temperature of a place. As elevation increases, the temperature falls. The cause of this is mainly that the atmosphere is warmed by contact with the earth, and not by the direct action of the sun's rays. The higher the situation the more is the locality, in the cold regions of the atmosphere, removed from the warming influences of the earth's surface. At the same time the heating effect of the sun's direct rays becomes more perceptible in high situations, because the clearness of the air, and its freedom from fog and moisture, permit the full heat of the sun to play upon the body, &c., without let or hindrance. Thus, in high altitudes, in the sun one may be scorched, while in the shade one may be freezing. The more elevated the situation, then, the more is it deprived of such modifying influences as have been noted in preceding paragraphs, such as proximity to masses of water, watery vapour in the air, and so on. In consequence the variations of temperature are extreme and sudden. As a general rule the fall in temperature for increasing elevation is 1° Fahr. for each 300 feet of ascent. There is what at first sight looks like a very remarkable exception to this rule that temperature falls with increasing height, namely, that, at night, in calm dry clear weather, and in frosty weather, localities situated on a height are actually at a *higher* temperature than those in the valley. The reason of this is that, after sunset, the heat radiates rapidly from the earth, and the layer of air in contact with the chilled surface becomes in turn quickly cooled down. This cooled air being denser than the warmer air above it remains low-lying. In the case of hill slopes and valley, other circumstances being equal, the air in contact with the surface of the hillside will also be cooled down, and then owing to its increased density will flow down to fill the valley, while warmer air will supply its place on the slope. The cold of the night and of frost will, therefore, be felt less on the slope of the hill than at its foot. In the mind's eye one can picture, on a clear frosty night, the cold air currents flowing down the hillsides, like so many streams of water, into the valley, till the plain beneath is completely submerged beneath a sea of cold air, rising higher and higher, but above which the more elevated parts of the slope remain in warmer air. This is a point worth remembering in fixing upon a place of residence in an undulating country.

Prevailing Winds modify the temperature of localities very markedly. The warm westerly and south-westerly winds, for example, of our own climate, laden with moisture, raise the temperature of the western side of the British islands. If the winds blow from the direction of mountain ranges which are so high as to be perpetually capped with snow, they will depress the temperature; while if they come from the direction of hot, sandy deserts, they will raise the temperature. Winds blowing from the sea necessarily carry a considerable quantity of moisture, and this moist air, passing over a district exposed to the full blaze of a burning sun, will moderate the temperature of the place by the screen the watery vapour interposes in the path of the heat rays. On the other hand, passing over a cold region, the same moist wind will raise the temperature by diminishing the loss of heat by radiation from the surface of the earth, and by the deposition of its moisture liberating the heat which the water held in a latent condition while in a state of vapour. Moist ocean winds are, then, cooling in summer and warming in winter. On the other hand, dry winds blowing from continents raise the temperature in summer and lower it in winter.

The Position of Mountain Ranges, Hills, &c., is most important as an influence in determining the warmth of any particular locality. The hills may act as a barrier to cold winds. An excellent example of this is San Remo, the well-known Mediterranean health resort. Its prevailing winds are northerly, but it is guarded by a semicircle of mountains of the Maritime Alps. Though these ranges are interposed as a baffle-plate, as it were, between the cold north and north-east winds, which are thus deflected upwards, high over the sheltered piece of coast-line, so that they never strike the town, they yet have an effect upon the temperature, preventing it becoming excessive. The situation of a locality in relation to mountain gorges, valleys, &c., is another illustration of the same fact. For example, there is a considerable difference in warmth between the eastern and

western bays of Mentone, due to the fact that the mountain shelter of the eastern bay is complete, while, on the western bay, there are open valleys of the mountain range, down which the cold winds more readily sweep. Mountain ranges, hills, &c., may also serve to keep a locality cold if by their situation they screen it from the sun's rays.

The Influence of Ocean Currents in determining temperature is illustrated by the effect of the most important of such currents, that of the Gulf-stream, on the climate of Western Europe. "If no more heat is received than is due to the position of the globe in respect of latitude, the mean winter temperature of Shetland would be only 3° and that of London 17°. But, chiefly owing to the heat given out by the Gulf-stream during winter, and carried to these places by the winds, their winter temperatures are respectively 39° and 37°—Shetland being thus benefited 36° and London 20° from their proximity to the warm waters of the Atlantic. In Iceland and the Norwegian coast, the increase thus accruing to the winter temperature is much greater. To these places the Atlantic may be conceived as a vast repository of heat, in which the warmth of the summer months, and that of more southern regions, are treasured up and reserved against the rigours of winter" (Buchan). But for this stream the British climate would be fully 20° colder in winter than it is. "As regards their influence on climate," says Buchan, summarizing the results of Admiral Fitzroy's observations, "ocean currents raise the temperature of the west of Europe, the east of South America, the east of Africa, and the south of Asia; and depress the temperature on the east and west coasts of North America, the west coast of South America, the west coast of Africa, the east coast of Asia, and the south coast of Australia."

Other circumstances affect the temperature of a locality which it is scarcely necessary to consider at length. We may notice, for example, the form and colour of hills, cliffs, &c. The form of hills partially surrounding a locality may be such as to cause the sun's rays, reflected from them, to be concentrated on the place, and specially will this occur if white cliffs, rocks, &c., form part of the range, by which the reflection would be much greater.

The Meaning of Mean Temperature, &c. —There are certain technical expressions employed in describing the temperature of localities, which, in view of their subsequent use, it may be well to explain here. In the first place, the distinction between "heat in the sun," or "sun heat," and "heat in the shade," or "shade heat," should be noticed. The latter is the heat of the air, direct rays of the sun being prevented falling upon the thermometer, as well as rays reflected from any surface in its neighbourhood. The thermometer is usually exposed to the air in a louvre-boarded box, at a height of four feet from the ground, at a distance from walls or objects likely to be heated by the sun, and over old grass freely exposed during the day to the sun. The former expression, "sun heat," is applied to the heat obtained near the surface of the ground in such a position that the rays of the sun fall directly upon the bulb of the thermometer, which is coated with lamp-black to enable it to absorb as much heat as possible.

The mean daily temperature is obtained by observing the temperature every hour, summing the results and dividing by 24, or by observing the highest temperature of the day, obtained by the maximum thermometer, and the lowest temperature of the day, obtained by the minimum thermometer, and taking their mean. The latter is now adopted and need imply only two daily observations, one at 9 a.m. and the second at 9 p.m. From these mean temperatures, the mean temperature of a week, a month, or a year may easily be calculated. The **mean annual temperature** is not of very high value in estimating the value of any locality as a health resort. Two places might have the same mean annual temperature, but that of one might be composed of a low winter temperature compensated for by a high degree of summer heat, while that of the other might be made up of a winter temperature not low and a summer temperature not high. The former climate would have extremes of heat and cold, the latter extremes of neither. For estimating the value of a climate for health purposes, then, it is best to obtain the mean temperatures for the seasons, spring, summer, &c., or still better the mean temperatures of the months. In the same way two places may show the same mean *daily* temperature, but one may enjoy a temperature which varies by only a few degrees in the twenty-four hours, while the other may have excessively hot days followed by very cold nights—made up of two extremes, that is to say. Obviously the former is more suitable from a health point of view. Therefore, to enable one to estimate the suitableness of a locality, one seeks to know not only the mean monthly or daily temperatures, but also the two elements

which go to form the mean daily temperature, the highest and lowest temperature of the twenty-four hours. "Thus in the north-west parts of the United States of America the temperature in spring often rises to 83° during the day, and falls to freezing during the night." This would give a mean temperature of 57°·5, which, it is apparent, if stated by itself would give an altogether erroneous impression.

The difference between the extreme day and night temperatures is called the **range of temperature**, and the less the range the more equable is the climate.

In this country temperature is stated according to **Fahrenheit's scale**—freezing point 32°, boiling point 212°. On the Continent the **Centigrade or Celsius' scale** is employed—freezing point 0°, boiling point 100°. It may be well to note how these may be converted, the one into the other. To convert Centigrade into Fahrenheit, multiply by 9, divide by 5, and add 32.

$$\text{Thus, } 100^\circ \text{ Centigrade} = \tfrac{900}{5} + 32 = 180 + 32 = 212^\circ \text{ Fahrenheit.}$$

To convert Fahrenheit into Centigrade, subtract 32, multiply the remainder by 5, and divide by 9.

$$\text{Thus, } 212^\circ \text{ Fahrenheit} = (212 - 32)\tfrac{5}{9} = 180\tfrac{5}{9} = \tfrac{900}{9} = 100^\circ \text{ Centigrade.}$$

Moisture of Air as it affects Climate.—Next to the temperature of the air, the amount of watery vapour the air contains is one of the most important circumstances affecting the climate of a locality. The difference between a dry climate and a humid climate is a difference only in degree, since all air contains some watery vapour. This has already been mentioned in discussing air on p. 682. It has been there explained that the capacity of air for absorbing moisture increases with its warmth. When air contains as much moisture as it can hold at a given temperature it is said to be saturated; and if the air then becomes cooled it must give up some of its moisture, which then becomes deposited in the form of dew, or falls as rain. Thus in the evening, when the sun has set, the heat rapidly passes off by radiation from the earth, and the surface of the ground becomes cooled. The air in contact with it, becoming thereby in turn cooler, is unable to retain all its moisture, and the excess is deposited as dew, the amount deposited being dependent on the amount of watery vapour in the air and the degree of cooling to which it is subject. The more rapidly, therefore, substances are cooled, the more speedily will dew be formed upon them, and the greater will be the amount deposited on them. Furs, wool, flax, silk, grass, and vegetable substances generally, cool more rapidly than gravel, stone, and sand, and on them more dew will appear. The cooling of the earth's surface is hindered by clouds, and the more effectually the lower the clouds are, for they radiate back to the earth the heat it gives off, so that a clear night is necessary for dew formation. Wind also hinders it, for it circulates the air and prevents the cold layer next the earth being formed. So also warm currents of air, laden with moisture, rising in the atmosphere and meeting with colder masses, are compelled to yield up a portion of their watery vapour, which then descends as rain or snow. Certain winds are, therefore, always accompanied by rain, since they bring with them, into colder latitudes, warmer moist currents, such as the south-west wind in our climate.

The air derives its moisture by evaporation as it passes over the surface of water and moist places. The warmer the wind is, the greater will be the amount of water picked up by it in its course. The actual amount of watery vapour held by a certain quantity of air is called its **absolute humidity**, but the quantity it holds in relation to the quantity it is capable of holding, at the given temperature, is called its **relative humidity**. Of two equal masses of air, both containing the same amount of watery vapour, but one of higher temperature than the other, the warmer will seem to be actually drier, because by its higher temperature it is capable of holding more water in the state of vapour than the other. It will not be so near its point of saturation as the colder mass of air; its relative humidity, that is to say, will be smaller. So that two masses of air may contain absolutely the same quantity of watery vapour, and yet one be called very damp and the other dry, because the former is colder than the latter. The relative humidity of air is expressed in terms of 100; that is, saturation is called 100; so that air whose humidity is 70 is $\frac{7}{10}$ths saturated. At sea, at night, the humidity of the air approaches saturation; in the interior of continents, amid dry sandy deserts, it falls very low. It is low at the hottest parts of the day and the hottest seasons of the year, and is high at night and in winter, in each case because of the temperature of the air.

The effects of the degree of humidity of the atmosphere on climate have already been alluded to in speaking of temperature. An atmosphere

rich in moisture, however clear and transparent it may appear to the eye to be, greatly intercepts the radiant heat of the sun on its way to the earth. The watery vapour absorbs the radiant heat, so that less reaches the earth than would were the air more nearly dry. In the same way the heat of the earth is not given off so rapidly by night when the air is moist; its radiation is checked. Heat is thus more slowly acquired during the day and more slowly parted with during the night. This cooling influence by day and warming effect by night aid in minimizing sudden alternations of temperature, and help to secure a more equal distribution of heat during the twenty-four hours. This effect may, however, become excessive, so that the atmosphere is sultry and depressing and wanting in exhilarating character. But wherever the moisture is deficient, in countries exposed to the full blaze of the sun, the heat is burning throughout the day and the nights may be bitter with cold. "In mountainous countries where, on account of their height, much less aqueous vapour is interposed between them and the cold regions of space, radiation, both solar and terrestrial, is least obstructed. It is this which explains the scorching heat that surprises the Alpine tourist while travelling over fields of snow under a blazing noon-day sun. And it is the same cause, the small amount of vapour in the air, that explains the intense heat experienced in the direct rays of the sun in the polar regions."

Rainfall is a matter of great importance from the point of view of the person seeking a desirable climate. But amount of rainfall is not of so much value as an indication, as the record of the number of days on which the rain fell. Thus the rainfall may be enormous at one portion of the year, and much smaller during the remainder. At Madras, for example, the rainfall during the wet season, October, November, and December, is 30 inches, and for the other nine months of the year only 19 inches. At Gibraltar 33 inches fell in 26 hours, at Genoa 30 inches in 24 hours, and on the Khasia Hills, north-west of Calcutta, 30 inches fell on each of five successive days. This latter was due to the southerly winds, soaked with moisture from the Indian Ocean, being forced to yield up the water by the hills driving them up into the higher and colder regions of the air. For the chief determining causes of a rainfall are winds laden with moisture, from passing over a sea or ocean, being deflected upwards into the colder regions of the atmosphere by ranges of hills opposing their level course. These are the conditions on the west coasts of Great Britain, Ireland, France, Norway, Spain, and Portugal. The prevailing winds being south-west, they lick up moisture from the Atlantic, and the rainfall is, therefore, considerable in the immediate neighbourhood of high hills. On the other hand winds passing over sandy deserts, continents, &c., are dry.

The number of rainy days increases with the distance from the equator. In the northern hemisphere between 12° and 43° of latitude the average number of rainy days in the year is 78, while it is 103 between 43° and 46° of latitude, 134 between 46° and 50° latitude, and 161 beween 50° and 60° latitude.

Many other circumstances go to the determination of the characters of the climate of any locality—the prevailing winds and the exposure of the locality to them, or its protection by hills, liability to mists, fogs, &c., cultivation of the soil, drainage, &c., which need not be further considered.

Effects of Climate in Health.—**The effects of excessive heat and cold** upon health, from a climatic point of view, it is not possible to state with certainty, so much do other circumstances, such as those connected with food, exercise, humidity of the air, &c., influence the results. Tropical heat tends to raise the temperature of the body of those coming from temperate climates, but the increase does not exceed 2° Fahrenheit, and this is in time diminished by the increased action of the skin. This increased activity of the skin induces the eruption known as prickly heat, because of the great determination of blood to the skin rendered necessary. Breathing is affected, the respirations being lowered, and the total action of the lungs being diminished, so that less carbonic acid gas is given out. This is doubtless the result of lessened combustion going on in the body, since a much less production of heat in the body is called for, and of the rarefaction of the air causing less oxygen to be supplied from the atmosphere. The heart-beats are also diminished, it would appear. Corresponding to the diminished need of the internal production of heat, there is a lessened demand for food, less appetite, though an increased desire for water, because of the need of liquids to make good the evaporation from the surface. The digestive powers are also diminished, perhaps because of the determination of blood to the skin. In fact, general bodily and mental vigour is depressed

in the case of persons belonging to a temperate climate proceeding to the tropics, though this is probably also a mixed result, dependent not only on the high temperature, but also on other conditions of the atmosphere, such as diminished oxygen, &c. It is generally believed that Europeans from temperate climates "do not flourish in countries much hotter, that is with a yearly mean of 20° Fahr. higher, as in many parts of India; that the race dwindles and finally dies out; and therefore that no acclimatisation of race occurs. And certainly it would appear that, in India, there is some evidence to show that the pure race, if not intermixed with the native, does not reach beyond the third generation. Yet it seems only right to say, that so many circumstances besides heat and the other elements of climate have been acting on the English race in India, that any conclusion opposed to acclimatisation must be considered as based on scanty evidence. We have not gauged on a large scale the effects of climate pure and simple, uncomplicated with malaria, bad diet, and other influences adverse to health and longevity" (Parkes). It is quite certain that the evil effects, ascribed so exclusively to the excessive degree of heat, have been largely due to the continuance of food, stimulants, and clothing, suited to temperate regions, but not adapted to the hot climate. A distinction is to be made between the heat due to the direct rays of the sun, **the heat in the sun**, and the heat of the atmosphere itself, **heat in the shade**. The latter is much less easily borne, because the hot air contains usually moisture, and the same degree of evaporation from the skin is not possible. Thus a sun heat of 120° can be endured when a shade heat of 90° to 100° is overpowering.

More moderate degrees of heat than that obtaining in tropical countries have similar effects in stimulating the skin and in diminishing appetite, respiration, and tissue change, but to a lessened extent. Persons who seek warmer climates, on account of weak health, do not usually seek warmth merely, do not seek, that is to say, simply to avoid cold, but also to avoid exposure to great variations in temperature; they seek to obtain a more uniform climate, to get rid of very pronounced currents of air which sudden changes of heat produce. It is to be noticed also that persons of weak general health require moderate degrees of heat to maintain the normal functions of body and mind, and that in their case the change to a warm climate is accompanied by a stimulus to the processes of life instead of a depression. In such persons the vital powers are already so depressed, that a degree of cold, which would exert only a quickening influence on the healthy body, almost paralyses them.

As to the effect of cold, it in general acts, on the healthy body, in a manner the reverse of heat, quickening the circulation, quickening digestion, improving the appetite, and accelerating tissue change. Provided appropriate food be forthcoming, all this is beneficial. By the healthy and vigorous, excessive cold is quite easily borne, being met by proper food and clothing. Supplied with these, the European, going from a temperate climate to the Arctic regions, can endure the cold and maintain his bodily warmth, while in a hot climate no device may enable him to keep cool. It is, of course, different with the delicate, in whom the diminished activity of the skin, by leading to the withdrawal of the blood to the deeper organs, is apt to occasion or maintain diseased states of lungs, kidneys, &c.

The effect of the degree of humidity of the air in health depends on the increased evaporating power of dry air and the diminished power of moist air. A dry air will encourage evaporation from the skin and lungs. But the air may be so dry, as in the case of the dry sirocco, that this becomes excessive, leading to harshness and dryness of the skin. The evaporating power, it is to be remembered, is to be considered not only in relation to the amount of moisture in the air but also to the temperature of the air, for a dry cold air will not absorb so much moisture as a dry warm air. In dry warm air the skin is specially stirred to activity, because of the flow of blood to it, to yield fluid for evaporation for maintaining the bodily heat at its proper level. When the dry air is cold, the skin is not so excited, since the blood is directed from the skin to the deep organs to prevent loss of heat from the surface, and it is the lungs which feel the stimulus. When the air is moist, on the other hand, the exhalation from both lungs and skin is lessened and a soothing rather than a stimulating influence is produced. When the air, in addition to being moist is warm, depression of the vital processes is the result, and oppression may be the result of the difficulty encountered by the skin of maintaining the balance of bodily temperature. Moist heat is one of the favourable conditions for the growth of putrefactive and other germs. In such circumstances diseases such as cholera, typhoid fever, diarrhœas, consumption, flourish. But when the air is at once moist and cold,

chilling of the surface of the body results, because of the moisture aiding the conduction of heat from the body. Colds and rheumatic affections are likely to arise, and catarrhal states of the air-passages, such as bronchitis, and of the kidneys, are often induced.

Winds are to be counted as beneficial or injurious to health according to their characters, moisture, and so on, and their force. Complete absence of wind is not healthy, since the absence of atmospheric currents means the want of due admixture of the air, specially necessary in populated places. High winds, whether hot or cold, dry or moist, are injurious to health. In Great Britain the east winds of winter and spring, from their dry and piercing character, are powerful agents in raising the mortality.

As regards the pressure of the atmosphere, changes in it and their effects on health have been already referred to on p. 680.

The Effects of Climate in Disease will be seen, from what has been said, to be a very mixed problem. It is not a mere question of removing an invalid from a place of low to one of higher temperature, or the reverse; a great many other factors enter into the question. The effects of heat, as we have seen, cannot be dissociated from the effects of atmospheric moisture, nor can these be considered apart from the effects of atmospheric pressure as it affects, among other things, the quantity of oxygen in the air. Then one cannot afford to overlook the fact of the presence or absence of foreign materials in the air, such as dust raised by winds, materials due to industries of the district, and, of still more importance, foreign particles of organized kind such as depend upon the proximity of marshes, the drainage of the soil, the nature of the vegetation, the character and habits of life of those native to the locality. Still further, in considering the effects of climate in the treatment of disease, one must not overlook the facilities afforded by various localities, or the reverse, for exercise, the probabilities of a great deal of outdoor life being possible because of equability of climate, and freedom from violent winds and sudden surprises by variation of temperature or rapid alternation of sunshine and rain. Not only must the possibilities of exercise be taken into account, but also inducements to exercise, because of the natural beauties of the locality or artificially created attractions. Finally, before any invalid decides upon a climate where he may hopefully seek restored health and renewed vigour, the possibility of adequate and suitable accommodation being readily obtained, with safety from risk of encountering other diseases, must be settled. The drainage and water-supply of many health resorts were for a long time of so primitive a description, and the conditions of life of the inhabitants so careless of sanitary laws, that the seeker after health too often found disease, of a more serious and debilitating character than that from which he sought relief. Happily so much public attention has of recent years been directed to these subjects that such risks are much less than they used to be, especially in the case of the most favoured health resorts. So complicated then is the influence which the climate of any particular place may have on a person suffering from ill-health, and so greatly will the total effect depend upon the actual condition of the patient at the time, that it is very often impossible to predict very exactly what kind of climate will suit him, so that he may be compelled to try one locality after another before finding that which he seeks. Moreover the climate suitable for a patient in one phase of a disease may prove very unsuitable at another. How often does a person, suffering from some chronic disease, who is in the habit of regularly visiting some particular health resort and always with benefit, suddenly at some subsequent visit find that he is no longer benefited, and that he must set out again in quest of a more congenial climate.

If then we proceed to consider what are the general requirements in the way of climate that seem indicated in the chief of the ailments for which change is sought, and the principal places where they are to be found, it must be understood that no absolute statement can be made, and that each invalid can have the question of climate settled for him only by a very careful study of his own condition and all that it seems to demand. We shall begin such consideration of climate, as suited to particular diseases, by taking that class of diseases which provides probably the greatest number of those who seek change, namely sufferers from diseases of the lungs and air-passages.

Climate suited for Diseases of Lungs and Air-passages.—No class of diseases exemplifies more fully the truth of what has been said regarding the difficulty of settling the question of suitable climate than this class. The requirements for such diseases are a pure air, a temperature not subject to great or sudden alternations, abundance of sunshine, plentiful opportunities for exercise, but whether it should be moist or dry, bracing and stimulating or soothing, depends upon the nature of each case.

For Consumption of the Lungs a great variety of climate has been recommended. Dr. C. T. Williams, a high authority on the subject, gives the following statistics of consumptives who passed one or more winters out of England with their results:—

		Percentages.	
		Much Improved and Improved.	Worse.
Sea voyages to Australia, America, India, China, the Cape and West Indies	45 winters	89	5·5
Very dry climates; Egypt and Syria	26 ,,	65	10
,, ,, Cape and Natal	13 ,,	58·6	17·24
South of Europe and Mediterranean Basin, &c.	152 patients	62·5	17·1
Rome	18 ,,	55·56	33·33
Warm Atlantic Islands, Madeira, Teneriffe, St. Helena, West Indies	70 ,,	51·43	34·29
Calm moist inland temperate climate, Pau, Bagnères de Bigorre..	44 ,,	50	45·45.

In this table the highest place is assigned to sea voyages, and the next to *dry* climates. Moist warm climates are the least beneficial, if not on the whole actually injurious. The cases most suitable for a sea voyage are those in which the disease is in its early stage, and it is the most appropriate means of treating the disease when it is but suspected, when the tendency exists, and when the desire is to guard against it if possible. The best route is that to Australia, when the voyage lasts ninety days, which allows time for the patient getting rid of any preliminary sea-sickness and becoming used to the life of ship-board. If, however, there is risk of protracted sea-sickness, it would be an indication against the voyage. The beginning of October is the time to set sail, Australia being reached early in January, and the return voyage should be begun not later than the close of February. The interval should be spent in the table-land of New South Wales, or in Queensland, or New Zealand, or in cruising, residence in the coast towns being avoided on account of the heat. The return may be made by the Suez Canal or Cape of Good Hope.

Dry *inland* climates like those of Egypt and South Africa are preferred where the marine stations prove too stimulating, and tend to produce undue excitement. The Mediterranean health resorts, such as those of the Riviera, Mentone, San Remo, Cannes, Nice, specially the two former, and Algiers, are at once dry and stimulating, and are suitable for a large number of respiratory affections. But acute cases ought not to be sent thither.

British patients, who can meet the moderate expense of change of air to a not too distant locality, but whose resources would be taxed by so far a journey as the Mediterranean, or whose strength seems scarcely adequate to the travelling, will find Ventnor, in the Isle of Wight, and other stations in the south and south-west of England, such as Hastings and Bournemouth, very suitable. These localities, according to Dr. Williams, are to be preferred to Torquay and Penzance. Regarding Ventnor, Dr. Hill Hassall has supplied some instructive statistics, derived from the reports of the Hospital for Consumption and Diseases of the Chest, established by him there. In the four years 1870 to 1873, 474 patients were treated, of whom 122 were improved, 161 much improved, 83 very much improved; 28 were restored; 34 were in much the same condition as when they entered; 22 became worse; and only 24 died. In 1878, of 501 patients admitted during the year, 106 were improved; 78 became much better, 150 very much better; 53 were restored; 36 remained in much the same condition; 62 became worse, and only 16 died.

The treatment of consumption by a residence in mountain climates has of recent years been brought prominently before the medical profession. While safety from consumption is nowhere absolute, certain striking facts have been brought forward regarding the mortality from consumption among Swiss natives living regularly at certain levels. Thus in the case of those living at a level of from 1250 to 1650 feet above the sea, consumption was the cause of 10·2 per cent of the total deaths. The mortality at a height of from 1725 to 2700 feet was, from the same cause, 9·4 per cent. In the high regions, 2700 to 4000 feet, the mortality fell to 5·1 per cent, while above 5000 feet the disease totally disappears. In the Upper Engadine (5000 to 6000 feet), and at Davos Platz, consumption is said to be unknown among those who have always lived there. "Above a height of 8000 feet, in the Peruvian Andes, phthisis (consumption) is almost unknown among natives; while in the coast lands in the same country it is common and rapidly fatal." Now in these high altitudes it is not warmth that is sought, for in the health resorts of the Alps the temperature is low, and the season is in winter,

from the middle of October to the end of March, the snow lying on the ground to a depth of 2 or 3 feet throughout that period. Still, in the direct rays of the sun, it is sometimes as warm as the midsummer of temperate climates. But the air is, if cold, very dry, and not liable to fluctuation; the sky is clear; and, owing to the bright sunshine, patients can be out of doors for most of the day, as they could not be in lower localities. The low temperature of the air, unfavourable as it is to putrefaction and to the propagation of the life of minute organisms, has probably something to do with the healthy influence. Undoubtedly another element in the beneficial effect is the low atmospheric pressure and consequent diminished density of the air. The effect of this is to produce expansion of the chest with accompanying expansion of the lungs. The effect of the climate of such altitudes is stimulating, both on heart and lungs, and also on the digestive organs; and there is consequent general improvement of nutrition. Nevertheless, all cases of consumption are not suited for such climates. Many could not bear the stimulating action of the high mountain air. The proper cases are specially those in the early stage, or those in a later stage, but not acute, where the disease is not extensive, and the patients have a good circulation and are able for a fair amount of exercise. Where there is risk of bleeding from the lungs the case is not suitable. In suitable cases complete arrest of the disease is often obtained.

The chief mountain resorts at present are the Swiss Alps, specially Davos Platz, 5140 feet above the sea-level, the Peruvian Andes, Santa Fé de Bogota, in New Granada, 8648 feet, a climate remarkable for equability, being 59° Fahr. in winter and 49°·5 in summer, Manitou Springs (6315 feet), Colorado Springs (5775 feet), and Denver (about 5000 feet), in the Rocky Mountains.

In regard to a summer health resort, the following are the conditions most suitable for the majority of consumptive cases, as stated by Dr. Hill Hassall: "The air should be dry, cool, moderately equable, but not cold; and the difference between day and night temperature should not be too considerable; the situation should be sunny, the sun neither reaching it too late in the day nor leaving it too early, as is the case with many of the mountain health resorts now in fashion; the elevation should not be too great, two, three, or at the most four thousand feet. I have known persons who have been sent to the Engadine suffer greatly in their breathing, even in summer, from the rarefaction of the air at that elevation, the difficulty being further increased by the great difference between the day and night temperature, and the cold of the early morning and afternoon as contrasted with the almost tropical midday heat."

In the lung condition known as emphysema (see p. 283) mountain climates are not to be recommended, but a mild not too dry resort, if possible in the neighbourhood of pine-woods. Arcachon, on the west coast of France, is recommended.

Bronchitis and other catarrhal affections of the respiratory organs, throat affections, &c., require climates similar to those already described for consumption, with the exception of those of high altitude. To those already named Hyères, in the south of France, may be added, and Arcachon, which lies south-west of Bordeaux. For chronic bronchitis, with much expectoration, dry climates are more suitable, while where the air-passages are irritable, and the expectoration is slight, a more moist locality is desired. Of the latter class Madeira may be taken as typical, which is noted for its soothing effect in irritable cough, allaying it in a very remarkable manner. In relaxed conditions of the system, however, with copious discharge, it is the reverse of suitable. The Azores and the Canary Islands are suitable in cases for which Madeira is. Teneriffe is the principal island of the latter group, and Orotava, a town on its north-western side, is provided with better accommodation than the capital, Santa Cruz. They are winter resorts; but at Orotava higher elevations are accessible, where in summer the excessive heat may be avoided. The English watering-places, Hastings, Ventnor, Torquay, may also be found useful.

Asthma.—The sufferer from asthma must in very many cases determine for himself what suits him best. Asthmatics are so commonly affected by the nature of the vegetation, that the patient is often driven from place to place, finding one place suit him at one season, and another at another season, according to the flowering time of certain plants. If the disease has been contracted in a moist climate, a dry one should be tried, and if it has been contracted inland, the sea-side may be resorted to. Mountain climates are very often useful; Madeira, and the Canary Islands, Pau, in the department of the Lower Pyrénées, and any of the climates already named as suitable for consumption may be found to yield benefit. In

Scotland, Forres, the hydropathic establishment of which is situated in the midst of a pine-wood, has a high repute for asthmatics.

The climate suited for heart affections is one rather bracing in character, moderately dry. Sudden changes of temperature, cold, and damp, are specially to be avoided. High altitudes are unsuited.

For diseases of the kidneys the climate must be warm and dry. The best for this purpose are Upper Egypt, Bombay, Cape of Good Hope, the Riviera, and in England Brighton, Folkestone, and Ventnor. Mountain climates are unsuited, and so are all moist climates. The latter diminish instead of stimulating the activity of the skin, and it is by the extra activity of the skin that the diseased organs are relieved. All cold and damp climates, by chilling the surface of the body and sending the blood to the deeper organs, are hurtful in such diseases.

Diseases of other abdominal organs will find suitable climate on the Mediterranean shore, or in the Lower Engadine, where Tarasp is specially recommended for the bilious and dyspeptic subject, the victim of chronic dysentery, or of nervous disorder consequent upon overwork. St. Moritz in the Upper Engadine is a favourite resort for sufferers from digestive derangements and sluggish circulation. For such disorders also the bracing influence of sea air is valuable, such as may be obtained in the health resorts of the south of England, Hastings, and Ventnor, or on the Irish coast, Queenstown. The association of baths and mineral waters with the climatic treatment is of great benefit in all disturbances of the abdominal organs, specially such as are attended by sluggish liver, constipation, &c., and the appropriate baths are noted in the part devoted to medicines. For feminine complaints the same thing is true.

The climate for malaria is that of high elevations, and bracing sea-side resorts, such as those of England.

The climate for nervous diseases varies according as the treatment indicated is of a stimulating or soothing character. Of the latter Arcachon in France is recommended for the calming and yet tonic action of the pine-woods, and dry inland climates, such as those of Upper Egypt, and the districts of Cannes away from the sea. Pau, in the Lower Pyrénées, is advantageous because of its calm atmosphere, which is very soothing to those of an irritable temperament, in whom nervous excitability is pronounced. Hyères is also advised in similar circumstances, Pisa in Tuscany, Venice, and Ischl in Austria. Biarritz, near Bayonne, on the west coast of France, is more bracing and exhilarating, being exposed to the winds and the influence of the Atlantic. Also, as a change from the more sedative climates, moderate mountain climates may be selected in summer. Nervous disorder, the result of overwork and worry, is best treated by a sea-voyage and the bracing influence of the sea-side resorts of temperate climates, such as the east coast of Scotland or the coasts of Ireland, or that of the island of Heligoland in the German Ocean.

The climate for scrofula ought to be one by the sea-shore, such as abound in the British Islands, the south and south-west in winter, and the east in summer; of the former Brighton, Isle of Wight, Bournemouth, and in Scotland Rothesay, and of the latter Scarborough, Lowestoft, the south coast of Fife in Scotland, or by Stonehaven in Aberdeenshire. Of the foreign resorts Algiers, Biarritz, Sicily are the chief.

In diseases of the general system and in convalescence from acute disease the Riviera is generally selected in winter and some more bracing mountain or sea air in summer. In England the health resorts of the south coast, and in Scotland Bridge of Allan, and Rothesay in Bute, are the winter resorts.

HEALTH RESORTS.

We shall now proceed to indicate a few of the chief features of some of the principal and best known health resorts, and any facts which may be of value to those in search of change of air and scene, in aiding their decision.

Various classifications have been proposed for climates. For instance one might divide climates into tropical, temperate, and arctic, a classification based on latitude. This would be of little use in indicating those suitable in the treatment of disease. Dr. Hermann Weber adopts two great divisions—Marine Climates (Island and Sea-coast), and Inland Climates. He classifies the former according as they are humid, or moderately humid, or dry, and the latter as mountain and lowland. Probably the purpose of those who consult this book will be best served if, without adopting any classification, we simply note various health resorts according to their geographical position, according to the country to which they belong.

British Health Resorts.

We have noted that the winter temperature of Great Britain is dependent upon the warmth

brought to its shores by the Gulf-stream and the winds blowing from it. As might be expected it is the west coasts that benefit to the greatest degree by this influence. The lines of equal temperature run north and south, not across the islands, in winter, the temperature all along the east coast being 37°, while along the west coast it is 39° and 40° and rises to 42° and 43° in the south-west of England. "Since the temperature of the whole of the eastern slope of Great Britain is the same, it is evident that to those for whom a milder winter climate is required, a journey southward is followed by no practical advantage, unless directed to the west coast. And as the temperature on the west is uniform from Shetland to Wales, Scotland is as favourable to weak constitutions during winter as any part of England, except the south-west. The temperature on the south-west of England and Ireland being, however, 4° higher than the west of Scotland, the mildest climates, and therefore the most suitable resorts for invalids who require a mild climate, are to be found from the Isle of Wight westward, round the Cornish peninsula to the Bristol Channel, and from Carnsore Point in Ireland to Galway Bay" (Buchan). This region is characterized by its mild character and the shelter from the north and east, while its southern exposure and sea influence make it a very suitable region for winter resort.

The Isle of Wight is one of the most important of the winter health resorts in the region named. The Undercliff, on the south-east portion of the island, a landslip which forms a kind of terrace, about six miles long and half to three-quarters of a mile wide, is the chief part. It is protected from the north, north-east, north-west, west and south-west, by lofty downs of chalk and limestone, so that it is open directly only to the south, south-east, and obliquely to the south and south-west. In this district are **Bonchurch, Ventnor,** and **St. Lawrence.** "From and including Bonchurch, to the village of St. Lawrence beyond Ventnor, we have the most favoured and best protected portion of the Undercliff district, and the best adapted for the winter residence of the delicate; as we advance more to the west, the protection is less as a whole, though undoubtedly equal to that of the eastern Undercliff, in many of the sheltered little nooks. Moreover, owing to its elevation above the level of the sea, the Undercliff differs from most situations on our coast, in being less exposed to the direct and immediate influence of the sea-air" (Sir James Clark). Ventnor is built on a series of terraces, varying in elevation from 400 to 700 feet, and this affords a variety of climatic condition dependent upon the elevation. The mean winter temperature of the Undercliff is 42°·14, and the mean daily range 10°; the average annual rainfall is 26·23 inches, and the number of rainy days 144.

The climate is well suited for general conditions of ill-health, scrofula, anæmia, &c., in convalescence from acute disease, in chronic catarrh of the throat and upper air-passages, and in cases where the tendency to consumption is feared. The soil is dry, and the place has the great advantage of affording abundant space for outdoor exercise, amid picturesque scenery.

Bournemouth, which is situated on a bay at the south-western extremity of Hampshire, is one of the most favoured of English health resorts. It is sheltered by extensive fir plantations, growing on surrounding slopes. The soil is sandy, and though this is of advantage by rapidly draining off surface water, in summer high winds blow clouds of it in a very disagreeable fashion. Its mean annual temperature is 49°·4, and it is blessed with a large amount of sunlight, and out-door exercise is agreeable. It is sheltered from the north, north-east, and partly from the east, but is less protected than the Undercliff and Torquay, though its temperature is somewhat lower than that of these places, while its atmosphere is less depressing. "There are two descriptions of persons to whom this climate offers great advantages," says Dr. Aitkin, "though neither may be said to labour under actual disease. In the first place, to persons who have long been resident in hot climates, and whose constitutions have, consequently, undergone changes that render them peculiarly susceptible of morbid impressions, resulting from the cold and dampness which prevail over by far the greater part of Great Britain. In the second place, to the young, who either from hereditary or accidental causes are of a weak habit of body, and whose tender and delicate constitutions, though unaffected with actual disease, yet are a constant source of apprehension and anxiety to their parents." It is a suitable place specially for delicate, sickly and rickety children, to whom its sands afford ample scope for amusement and exercise, while it is not unsuited for consumptive patients who are able to take a fair amount of exercise. The effect of the exhalations from its pine plantations is believed to be salutary in lung affections.

Weymouth, or **Melcombe Regis,** also with excellent sands and well protected by the bay,

Sidmouth, open to the south but sheltered from the north, north-west, east, and partially from the north-east, resembling Torquay, though somewhat colder, **Exmouth** and **Teignmouth**, are the chief places, as one travels westwards from Bournemouth till Torquay is reached. Sidmouth, Exmouth and Teignmouth are specially summer resorts, the last two being insufficiently sheltered, and not suited as climates for lung complaints during winter, because of this as well as because of a too variable temperature, while their bracing character makes them valuable resorts in summer. Exmouth consists of an old town, situated on a hill and exposed to high winds, and a new town more sheltered, but damp from its proximity to the river.

Torquay is celebrated for its mild climate and equable temperature. Situated on the north-east corner of Torbay, and surrounded by hills, which shelter it from north and north-west winds and in great measure also from north-east, and situated in one of the most beautiful districts of Devon, it presents to the invalid manifold attractions. Its mean winter temperature is 44°, higher, according to Mr. Vivian, than that of any other place in Great Britain; its annual rainfall is 28·2 inches, and the average annual number of rainy days 132. Its climate is not only warm and mild in comparison with many other places, but its characteristic is dryness, as compared with other parts of South Devon, supposed to be due to its position between two streams, the Dart and the Teign, which draw off the moisture, or to the limestone rocks, or the elevation of Dartmoor. The autumn and winter months are the least dry. The town is built on sites of varying elevation, the slopes being covered with villas, and thus, while the lower levels are mild and relaxing, more bracing atmosphere can be had within the limits of the town itself. It is a favourite place for persons suffering from general debility, for whom it is eminently suited, as a winter resort, and for consumptives, for whom, however, its moist air is scarcely to be commended if they can seek drier climates, though it is recommended in chronic bronchitis, pleurisy and asthma.

Dawlish, not far from Exmouth, is sheltered from the north and north-west, but open to the east, and is hence not a desirable place in spring.

Salcombe, further westwards than Torquay, is warm enough to permit the myrtle, lemon, orange, and aloe, to flourish naturally, and is said to be the warmest place on the south coast. It is, however, moist and relaxing, and the accommodation is restricted and room for exercise limited.

Penzance, on the shore of Mount's Bay, is the principal health station of the Land's End district. It faces the east, but is sheltered from western gales. It is 5° warmer in winter than London, and its temperature is equable, having a mean daily range of 6° as contrasted with 11° in London. Its winter temperature is less cold by many degrees than that of any other part of the kingdom, except Torquay, being 44°. The winter, however, if mild, is wet and the summer cool and moist, producing a feeling of languor and depression, so that its influence is decidedly sedative. The average rainfall is 44·66 inches, and the average annual number of rainy days 178. "In April and May it is decidedly inferior to the more sheltered spots on the south coast of Devon, and to the Undercliff" (Clark).

Falmouth, 30 miles eastwards, has a similar climate.

The Channel Islands possess a moist, equable climate, like that of the south-west coast of England generally. They are, however, exposed to high winds, and are subject in spring to the piercing north-east winds, so that they are rather summer than winter resorts. The climate is soothing and relaxing, as all warm moist climates are, and not suitable for patients who need a bracing air, such as those suffering from nervous or physical depression. Rheumatism prevails in Jersey.

The Scilly Islands, 42 miles from Penzance, and 25 from Land's End, possess the most equable winter temperature in the British Islands, if not in all Europe, according to Dr. Tripe. The mean temperature from November to March is 47°·9, but the moisture of the atmosphere is high.

Brighton, Eastbourne, St. Leonards and Hastings, on the south-east coast, are favourite summer resorts, as well as providing for suitable cases a winter climate.

Brighton extends along the coast for three miles, and its eastern and western portions differ considerably. The eastern portion is dry and bracing, the western more mild and damp. Sir James Clark says "delicate, nervous invalids generally feel better in the western part. Those, on the other hand, who suffer from a relaxed state of the system enjoy their health more fully in the eastern district. . . . Compared with other parts of the south coast, the climate of Brighton appears to the greatest advantage in the autumn and the early part of winter, when

it is somewhat milder and more steady than that of Hastings. Accordingly in all cases in which a dry and mild air proves beneficial, Brighton, during this period of the year, deserves preference over every other part of this coast. In the spring, on the other hand, owing to its exposure to the north-easterly winds, the climate is cold, harsh, and irritating to delicate constitutions. At this season, therefore, sensitive invalids generally, and more especially persons with delicate chests, should avoid Brighton." In summer it is a most attractive sea-side resort. The summer season is from June to the middle of October. March, April, and May are the worst months for invalids, so that from October to March is the appropriate winter season.

Hastings and with it **St. Leonards** are suitable for the consumptive to an extent resembling the Undercliff of the Isle of Wight. They are sheltered by tall cliffs, 300 to 600 feet in height, from the north, north-east, and north-west, less so from the east, the exposure being thus south and south-west. Hastings is more soft and sheltered than St. Leonards. The lower parts of the town are more under shelter than the higher, and therefore warmer. From the beginning of November to the end of March is the appropriate season, during which the mean temperature is 41°·4. The soil is dry, sand overlying clay. Of Hastings Sir James Clark says: "As might be expected from its low and sheltered situation, it affords a favourable residence generally to invalids labouring under diseases of the chest; hence delicate persons, who require to avoid exposure to the north-east winds, may pass the cold season here with advantage. But in recommending Hastings as a residence in such cases, it will be necessary to take into consideration the full influence of the sea-air; for, owing to the close manner in which this place is hemmed in on the sea by steep and high cliffs, it has an atmosphere more completely marine than almost any other part of this coast, with the exception of St. Leonards. Judging from my own experience, I should say that the climate of Hastings is unfavourable in nervous complaints, more especially in nervous headaches, connected with, or entirely dependent upon, an irritable condition of the digestive organs, and also in cases where a disposition to apoplexy and epilepsy has been manifested. But it will be understood from what has been already stated respecting the topographical relations of Hastings, that this effect of its climate is chiefly experienced in the lower and more confined parts—nor is such an effect peculiar to this place, it is common, I believe, to all places similarly situated. The class of persons alluded to, if induced to reside for any length of time at Hastings, should avoid the more confined situations below the cliff, and rather seek such quarters as are more open and elevated, yet in some degree protected from north and north-east winds. These remarks on the climate of Hastings apply to it as a winter residence; as a summer residence the more open and exposed situations should be sought, and for many persons the high grounds behind Hastings would be preferable to the lower situations close to the shore." Dr. Hermann Weber says of it that as a winter climate it is less suitable for those requiring shelter, warmth, and a humid and equable atmosphere, but cases of atonic gout and rheumatism, and atonic catarrh of the mucous membranes, and tendency to colds from weakness, and atony (weakness) of the skin are generally benefited during the months of October to February. St. Leonards is not so warm for a winter residence; it is more blowy, more exposed to the east, less equable and more bracing. At both there is an excellent beach for sea-bathing, very bright, attractive, and bracing for children. Both places have the supreme advantage of offering to the visitor every kind of accommodation, convenience, amusement, and luxury.

The health stations situated farther to the east, **Hythe, Sandgate, Folkestone, Dover, Ramsgate, Margate,** are more suited for summer residences, and need not be considered here.

The east coast of England, like the east coast of Scotland, possesses many admirable watering-places, whose bracing tonic air is eminently fitted for the tired-out man of business or literary worker.

Yarmouth in Norfolk, **Lowestoft** in Suffolk, **Scarborough** and **Whitby, Redcar** and **Saltburn** in Yorkshire, are examples.

On the west coast of England **Bude,** on the north coast of Cornwall, **Barnstaple** and **Ilfracombe** on the North Devon coast, are examples of watering-places, not quite suited for winter residence for invalids because of their exposure, and not too bracing in summer.

The Welsh watering-places, **Aberystwith, Barmouth, Beaumaris** on Anglesea, and **Llandudno,** all partake of the same general characters, mild and humid, and they are all exposed to the westerly winds, except the last, which is sheltered by the Great Orme's Head from the west, north-west, and north, and by another and a lower range from the south and south-east. It

is a possible health resort for those who can endure some amount of wind.

Southport, New Brighton, Blackpool, on the north-west coast of England, are excellent summer seaside resorts.

The Isle of Man, Dr. Weber says, deserves to be more appreciated. Its summer climate is more bracing than that of any locality near the western coast, and the sea-bathing is very good.

Scotland possesses two chief winter health resorts, Rothesay and Bridge of Allan.

Rothesay is situated on the Island of Bute, which is 18 miles long and 4 to 6 broad. It is surrounded on all sides by hills of the opposite coasts. Its temperature never falls low in winter nor rises high in summer, but its climate, though mild and equable, is very humid. It is excellently suited in the winter and spring months for the invalid who desires shelter from the cold of the season, but is not suffering from any particular disease; but it is too depressing and relaxing in summer for most people. "Every part of Bute is not equally mild during winter. The eastern is much milder than the northern coast, owing to its being in some measure protected from the influence of the north wind. The climate of this island may be styled as mild and equable, but rather humid. It resembles in character that of the south-west of England and France, and of the Channel Islands, though it is considerably less warm than any of these. As a winter residence for invalids it holds out considerable advantages to that class only for whom a soft, equable, but rather humid atmosphere, is indicated." Anyone with chest affections should not try it unless under medical advice. The accommodation and bathing facilities are all that could be wished.

Bridge of Allan, within a short distance of Stirling, is built on sloping ground well wooded, which protects it from the east wind. "From its sheltered position, the east wind passes over it at a reduced rate and force, and there being consequently less evaporation, our bodies are deprived of less heat, and thus the sensation of greater warmth which we feel is a reality. Again, being built on rising ground, the cold air flows down to the valley below it, so that excessive cold rarely occurs" (Buchan). The climate of Bridge of Allan is suited for the same class of cases as Rothesay.

If Scotland is poor in winter health resorts, "the whole land 'frae Maiden Kirk to John-o'-Groats,' is itself one great health resort for summer, when from early June to the late days of October, the stream of tourists pours unceasingly by glens and mountains, by lakes and rivers, such as few lands can excel for beauty." All along the east coast are to be found watering-places, unrivalled for their facilities for sea-bathing because of the long stretches of sandy shore, affording a bracing invigorating climate, though practically unsheltered from the winds. North Berwick on the southern shore of the Firth of Forth, Elie on the opposite coast, St. Andrews on the north-east coast of Fife, and the shores of Aberdeenshire are examples of seaside resorts of a stimulating and innerving character.

The west coast of Scotland is less bracing in summer, but is cooler and is more humid.

Of the health resorts of Ireland **Queenstown,** on the southern portion of the Island of Cove, in Cork Harbour, is suitable in winter under the same conditions that make the winter resorts of the southern coast of England advisable. It has a very mild and equable climate, has a southern exposure, but is sheltered from the north. Its mean winter temperature is 44°·21, and spring 50°·17. It is not suitable for anyone to whom a moist somewhat relaxing climate might prove injurious. In asthma and chronic bronchitis, with irritable cough, it has been recommended; but it is too moist, as a rule, for consumptive patients.

Glengariff, off Bantry Bay, is of similar characters and of much natural beauty.

In general it may be said of Irish as it is said of the most of the British seaside resorts that their equability of temperature, their relative warmth—a feature, as already pointed out, of all climates, whose dominating influence is the ocean—make them useful to those who do not require special protection; but that their high degree of moisture render them unsuitable in serious lung and kidney affections specially, as well as in rheumatic and gouty conditions. In scrofulous conditions, in convalescence from acute diseases and from surgical operations, and in persons in the enjoyment of fairly good constitutions, but suffering from overwork and strain, whether mental or physical, with fair digestive power and not liable to nervous irritability, they are to be recommended. The eastern coasts, it may be accepted as a general rule, are drier and colder, and the western warmer and more moist, but with a duller atmosphere. It is only on the western portion of the south coast of England that there are to be found climates with fairly dry atmosphere.

Another marked point of contrast between them and the health resorts of the Mediter-

ranean, considered in the succeeding paragraphs, is the large number of rainy days they have annually, and the distribution of the rainfall throughout the whole year, so that days without rain cannot be reckoned on. Then the number of hours during which the rain continues on each day is more than in the more favoured southern climates. This is illustrated in the next paragraphs more fully.

Mediterranean Health Resorts.

The Western Riviera.—In the following paragraphs we shall consider very briefly only the best known of the health resorts of the northern shores of the Mediterranean. The chief of these are Hyères, Cannes, Nice, Monaco, Mentone, San Remo, the group which belongs to the district known as the Western Riviera.

The great characteristic of these localities is warmth accompanied by moderate dryness. They are more or less completely sheltered from northerly winds by the mountain chains of the Maritime Alps, though the different parts of the district vary in this respect, according to their proximity to gorges and valleys in the mountains, down which the cold winds may sweep. The soil is dry, the higher mountains being limestone. The mean annual temperature is about 60° Fahrenheit, Mentone being 60°·93, San Remo 60°·13, and Cannes 59°·9. Now that of the Undercliff, Isle of Wight, is nearly 9° less, and Bournemouth fully 11°. The mean winter temperature is 48°·98 in Mentone, 7° higher than that of the Undercliff. The thermometer rarely falls below 29° or 30° at night. The temperature in the sun is very great, but, notwithstanding, the daily range of temperature is comparatively small, being on a mean between 9° and 10°, for San Remo it is given as 9°·22. This is in consequence of three circumstances: first, the Mediterranean Sea, which equalizes the temperature, the explanation of which is given on p. 776; second, the sea breeze which prevails throughout the day, and thus cools the atmosphere at its hottest period; and third, the proximity of the mountains, which absorb the heat during the day, and radiate it at night upon the district, acting, as it has been said, like a warming plate to the shore. The number of sunny days is five times greater than in London. In Mentone, according to one authority, they averaged 214 in the year, 45·7 being partly sunshiny, 24·8 cloudy, and 80·8 rainy. Fog and mist are rare. The rain falls chiefly in September, October, and March. The number of rainy days per year of the chief resorts of the Riviera, and their contrast with other well-known places, are given by Dr. Hassall as follows:—

San Remo	48
Mentone	80
Nice	70 or 60
Cannes	70
Hyères	63
Pau	119
Malaga	40
Madeira	88
Ventnor	174·6
Bournemouth	156·3
Torquay	200

The atmospheric moisture is over 20 degrees less than in London, and it is the comparative dryness of the air that is one of the chief features of this district. The district is protected from the direct impact of the north winds by the mountain barrier. Nevertheless it is to their cold and dry characters that are attributed the clearness of the atmosphere and brilliance of sunshine. The wind which plagues these Mediterranean shores is the north-west or "Mistral." "It is a steady violent north-west wind which blows from France down on the Gulf of Lyons. It is immediately caused by the low atmospheric pressure in the Gulf of Lyons, as compared with the pressure to the north, and is most severe when at the same time very high pressures occur from France northwards towards the Arctic regions," which draw over the northern shores of the Mediterranean the polar current in its full strength, which becomes still colder and drier in crossing the Alps in its southward course. Such is Dr. Buchan's explanation. This wind is felt less at San Remo than at Cannes and Nice. While sheltered to the north, the Riviera is open to the south and south-west winds. It is to these that rain is due, bearing moisture as they do from the Atlantic as well as the Mediterranean. The south-east wind from the African deserts, as it strikes the southern coasts of Italy, is the Sirocco. Hot from the desert, but having swept up moisture from the sea, it comes as an exhausting wind. "It is the plague of the two Sicilies; and while it lasts, a haze obscures the atmosphere, and so great is the fatigue which it occasions that the streets of Palermo become quite deserted." Before it reaches the Riviera, however, it is cooled, and deprived of much of its evil influence, by the Italian mountains, but it is still felt sometimes as very warm and enervating. The mistral blows principally in March but occasionally also in winter and spring. The sirocco "blows only now and then for some days, and is then

almost always followed by heavy rain." The north-east wind is felt at the Eastern Riviera more than at the Western and is cold and biting.

As regards the most suitable period of the year for this climate, we quote the following from Dr. Hassall, who takes San Remo as a type of the district, and speaks from his own experience: "First, I recommend the intending visitor not to delay his departure from England too long, lest he take cold and his health be injured, but to leave it by the 1st of October, even if he do not come straight to San Remo, but spend a few days on the way; reaching it not later than the middle of the month, by which time the autumnal rains will usually be over and a period of dry and fine weather be expected. With regard to departure, this should be postponed as long as possible, and it should certainly not take place earlier than the middle or better still the end of May. The weather during the spring and early summer is usually most beautiful and enjoyable, being by no means hot. It is in the spring months that the patient usually derives the greatest amount of benefit from his sojourn abroad; it is then that the weather becomes fine, bright and warm, and the days long, so that he can be constantly out of doors with advantage; it is then that all nature awakes with renewed life, and the earth, the hills and mountains become clothed with new beauties, imparting endless pleasure to the invalid in his walks and excursions."

It is also advised that the health seeker should not return directly home, but should spend not less than a month on the way, among Swiss resorts for example.

There are certain circumstances that must not be forgotten by the invalid at the Riviera, if he is to derive full benefit from his residence there. The temperature in the sun and that in the shade differ very considerably. The temperature in a room exposed to the north is during the day several degrees colder than one with a southern exposure, specially if the direct rays of the sun are beating upon the latter. For while the shade temperature during the winter months is 55°·9, that in the sun may be as high as 128°·9 Fahrenheit. Invalids may require then to take the precaution of having a room with a southern exposure in winter. Then with the setting of the sun the earth speedily begins to cool, and there is a sudden change in the temperature, and the nights are sometimes very cold. Exposure at night must, therefore, be avoided, the invalid systematically returning home sometime before sunset. In view also of sudden alternations of temperature during the day precautions should be taken. "Invalids should be warmly clad, wearing in fact very much the same winter clothes they would do if in England, the object being to keep themselves as far as possible comfortably warm, even to the hands and feet. It is very advisable that they should carry with them, when out of doors, an extra coat or shawl, which even in the house it is often requisite to wear. The San Remese, and indeed it may be said Italians on this coast generally, very commonly carry a second coat, in readiness to put on, should the weather become suddenly chilly; and it is by no means uncommon to see men wrapped up in shawls, much in the same way as women. It is impossible to be too careful in this respect." "Invalids, especially if suffering from chest affection, should not go out when the air is damp, when it rains, or when strong cold or damp winds are blowing. They should be most careful about sitting out of doors; they must only do so when the sun is shining and they are themselves placed in some warm and sheltered situation. If a suitable locality be chosen they can often bask in the sunshine during the winter for hours together. It is advisable always to be provided with a sunshade, as, if the powerful rays of the sun are allowed to fall directly on the head, they frequently give rise to troublesome headaches of a congestive character. Over-fatigue should be scrupulously avoided; no long excursions undertaken, and above all, if the lungs be affected, climbing up the hills and mountains should be absolutely forbidden. Much mischief occasionally ensues from a neglect of these precautions."

We conclude these considerations of the general features of this district, by noting what is the kind of disease for which the climate is most suitable. It is eminently suited for that class of invalids, who, without actual organic disease, are yet broken down in health from overwork or strain. The dryness which accompanies its warmth, as well as the effect of the sea air and the bright sunshine, make it tonic bracing and stimulating, just such qualities as are desired in the class of cases named. Digestion is improved; and the processes of tissue change and repair are quickened. The skin and circulation are also stimulated. Those same qualities indicate the benefits likely to be derived by those recovering from acute disease, by the aged and those too rapidly aging. Delicate children are also suitable patients, especially those constitutionally so, from scrofula or similar

diseases of bad nutrition. Lung affections, of the consumptive kind, or of the bronchial variety, *if not acute*, are likely to improve with a sufficiently prolonged residence. But for some such cases the climate may be too bracing, for others, and this is more likely, it may not be sufficiently so. Each patient's own particular condition must be the indication of its suitability or otherwise. Consumption with a tendency to inflammatory action is deemed unsuited for treatment here, while the air is not sufficiently moist for nervous asthma. Digestive troubles, and disorders of the urinary and sexual organs may be aided in removal by the Riviera climate, but there are other much more suitable places, in which climatic treatment is combined with treatment by baths and mineral waters. It is not recommended in cases of heart disease nor for persons of a full habit of body, nor for those suffering from diseases of the nervous system.

We shall now note a few of the leading features of the chief resorts already discussed in their general features, noting any differences existing between them.

San Remo, situated on the Gulf of Genoa, is the typical place of the Riviera. Sixteen miles to the westwards is Mentone, 15 miles farther west is Nice, and Genoa is 85 miles farther east. It lies in a bay four miles broad, and is protected by an amphitheatre of mountain, rising gradually behind it from a height of 500 to nearly 4000 feet, the nearer ones being wooded with firs. East and west the promontories of the bay shelter it, and, unlike Mentone, it has within the circle of its hills no gorge or valley down which the north wind may sweep. It is more protected from the mistral than Cannes or towns farther to the west. The town contains 16,000 inhabitants. Corsica lies 80 miles to the south-east. The western part of the town stands on a higher elevation than the eastern and is nearer the sea, being consequently more bracing. Groves of olives shelter its lower levels. It is warmer than Nice or Cannes, though its annual temperature is slightly lower than that of Mentone, from which latter, however, it does not materially differ; while its rainy days, as shown on p. 790, are fewer. "Its climate," says Dr. Rose, "is intermediate between the east and west ends of Mentone, not so warm as the former and more sheltered than the latter, the air being also more soothing than at Cannes, Nice, and Mentone. This depends on the fact that the ground is covered to the water's edge with orange, lemon, and olive trees, thus preventing too rapid evaporation, and the soil, being principally clay, prevents the rain percolating through so rapidly as it would in sandy and gravelly soil." It has been noted that this soothing character of the San Remo air is in contrast with the more stimulating effects of the atmosphere of Nice, as shown by a tendency of the latter to produce sleeplessness, whereas in San Remo the air did not have this effect, "being tonic without being excitant, exhilarating and yet soothing." There is plenty of variety for walks and excursions, and the invalid who cannot venture far may exercise, sheltered by the orange groves.

Mentone, a town of 5000 inhabitants, is situated in the centre of a bay, about 4 miles wide, which is divided into an eastern and western portion by a projecting spur. The eastern portion is completely protected by the mountains which rise abruptly without break, and shelter it from the north, north-east, and north-west, while it is open to the south and south-east. The mountains behind the western portion are farther removed and are interrupted by valleys, through which the wind sometimes rushes with violence, and through which the mistral may find entrance, though modified by the mountains. The eastern bay is thus warmer than the western, but is rather restricted for exercise, while the western bay has plenty of space for exercise in parts well sheltered for the invalid. The difference of temperature between the two bays is so marked, that invalids residing in the eastern bay are advised not to pass the limits of that bay in the cold days of winter. Its mean winter temperature is between 48°·5 and 49°·5. The climate of Mentone "is warm, very dry, and stimulating; it is also very equable, being much less liable to sudden changes of temperature than Nice or Cannes. There is a want of circulation in the atmosphere, particularly in the eastern bay; and a close proximity of most of the houses to the sea subjects patients too much to the noise and stimulating effects of that element." But it is these qualities of the eastern bay that make it very suitable for some kinds of consumptive patients.

Monaco lies between Nice and Mentone, 10 miles from the former and 5 from the latter, on an elevated promontory. Just beyond it is the Casino of Monte Carlo. The lower town of Monaco is well protected on its westward side.

Nice is a town of over 40,000 inhabitants. It is not nearly so well protected by the Alps as any of the towns already named, because of its

distance from them and their lower elevation. Of it Dr. Hassall says: "It is insufficiently protected by its beautiful encircling mountains, especially from the north-east and north-west winds; when these blow, the city is liable to sudden and great changes of temperature; changes which are somewhat dangerous even to those in health, and positively injurious to persons suffering from lung disease. Were Nice better protected from objectionable winds, the climate would be nearly equal to that of the most favoured of the health resorts of the Western Riviera. Like that of the Riviera generally, it is, even in winter, bright sunny dry and stimulating. The average annual temperature is 59°·48, and the three months' winter temperature 47°·82; it is, therefore, colder than either San Remo or Mentone; the rainfall amounts to 25 inches, and the number of rainy days according to De Valcourt to 70, being greater than all the other towns of the Riviera, with the exception of Mentone. Although, therefore, the climate of Nice is at times trying and treacherous, and hence unsuited to most invalids, there are yet some who derive benefit from its stimulating and bracing qualities; as those suffering from simple debility, atonic dyspepsia, and scrofulous affections. For some aged people it also affords a good winter retreat, provided they are on their guard and conform to the exigencies of the climate." And Dr. Walshe says that in no stage, in no degree, and in no form of tuberculization of the lungs, and no matter what be the temperament of the patient, is Nice proper a safe winter resort.

Cannes, strictly speaking, is beyond the limits of the Western Riviera. It is a town of about 14,000 inhabitants, situated on the Bay of Napoule, on its eastern side. Nice lies 19 miles to the east of it. It is sheltered on the west by the Esterel Mountains, while Cape Croisette protects it on the east, and on the north, north-east and north-west, it is sheltered by slopes of the Maritime Alps. They are, however, too distant and too low to make the shelter complete, and the north-west wind—the mistral—is a greater plague at Cannes than at the other chief towns of the Riviera. A thick yellow dust frequently covers the roads, and is lifted and driven in clouds by the wind. The old town is built on a ridge, Mont Chevalier, 147 feet high, which divides the bay into an eastern and western portion; the former is the smaller of the two and is more sheltered from the mistral. Its climate is dry, bracing, and stimulating, with a mean winter temperature—48° Fahr.—somewhat lower than San Remo or Mentone, while it largely exceeds these in the number of its rainy days (see p. 790) and the amount of its rainfall—25 inches. It is, therefore, not so well suited for those suffering from chest complaints. It has, however, advantages of its own in its less confined area, in the variety and beauty of its surroundings, and its absence of closeness. On the slope of the mountains, about 1000 feet high, and distant from Cannes 8 or 9 miles, is **Grasse**, with a southern exposure and fairly well sheltered, and famous for scent manufactories and for preserved and crystallized fruits; while north-east is the village of **Cannet**, famous for pottery-ware, whose air is more soothing in its influence than that of Cannes. Opposite Cannes, about a mile from the shore, are the islands of St. Marguerite and St. Honorat. Thus the surroundings of Cannes are varied and beautiful, and it affords a great variety of walks and excursions, a not unimportant matter in considering what is to be the winter residence of invalids.

Hyères lies still further west than Cannes. It is built on the slope of a range of hills, 60 feet above the sea-level, and is protected from north and north-east, but is open to the north-west wind. Its exposure is southern, and it is 3 miles inland. Its mean winter temperature is 47°·3; its average annual rainfall is 27 inches; and its number of rainy days 63. "The climate of Hyères is very good between November and the beginning of February, with many calm and sunny days; it ought to be avoided after this period by those who are unable to bear the mistral, or at all events the greatest care ought to be exercised. In April and May Hyères offers again more advantages. Many cases complicated with nervous irritability do much better here, because it is less under the direct influence of the sea than Nice and Mentone" (Weber). This lessened stimulating effect of the climate of Hyères, as compared with that of Cannes, Mentone, or Nice, is shown by the fact that patients driven from the latter towns by sleeplessness have slept soundly at Hyères.

Genoa lies at the eastern end of the Western Riviera. Its mean temperature is 46°·56, considerably lower than the more westerly towns, with more days of rain, more frequent visitation of frost, and above all with an exposure to the north and north-east. It cannot be counted, therefore, as a winter health resort for the invalid, nor is it suitable as a brief place of

residence after a winter in milder climates. For those not strictly speaking invalid it has of course manifold attractions; and if its climate is not mild in comparison with San Remo it is yet bright and sunny.

Malaga, in Granada, on the south coast of Spain, 80 miles east of Gibraltar, is protected from the north and north-east by a range of mountains rising to a height of 3000 feet. It is, however, exposed to the north-west wind. Its winter temperature compares very favourably with those Mediterranean health resorts already named, being 54° to 55°, while that of San Remo is 48°·89, and its spring temperature 62°, while in San Remo it is 57°·32. The daily range of temperature is only 5°, the mean of that of San Remo being 9°·22. The air is drier than in the localities further east, and the number of rainy days is only 40, 8 less than at San Remo. February is the rainiest month. Its climate, which has been said to be the mildest climate in Europe, is warm, dry, equable, and bracing, but its exposure to the north-west wind, called here Terral, and which pours through gaps in the mountain chain and is laden with fine sand, is a bad feature. Invalids need to guard against the sudden fall of temperature after sunset, and the heavy dews. It is a suitable climate in the early stage of consumption, in chronic bronchitis with much expectoration, in bronchial asthma, and for children suffering from scrofulous affections. It is not advised for persons with nervous affections, or who are liable to apoplexy, or who suffer from neuralgia or chronic rheumatism.

Ajaccio, in Corsica, faces south-west, being sheltered from northerly winds. Its mean temperature in winter is about 54°, in spring 59°. The air is, however, moist, 80 per cent of saturation, and during the winter and spring the rainy days number 35.

Other Continental Resorts.

Pau is inland, situated in the south-west of France, in the department of the Basses-Pyrénées, 56 miles east-south-east of Bayonne. In a valley and surrounded by the mountains, its sheltered situation produces a very calm atmosphere. This renders it somewhat relaxing. Its mean temperature during the season—November to April—is about 48°·6, and the air is less dry, there are more rainy days—119—and a greater rainfall—43 in.—than in some of the chief places of the Riviera. The soothing influence of its climate is suitable in irritable conditions of the throat and air-passages, and in irritable conditions of the nervous system, and spasmodic asthma. Thus in chronic bronchitis with dry, worrying cough, it exerts a sedative effect. Rheumatism is said to be a common complaint among the native population. Occasional storms disturb the atmosphere, and in the later months of spring the weather is somewhat unsettled.

Biarritz lies on the coast of France within a few miles of the Spanish frontier, in the same department as Pau. It fronts the Atlantic and is quite unsheltered. It has therefore the characteristics of the most of seaside resorts open to the west. Its air is rather moist, and rain is apt to be frequent. But it has a dry soil. It is bracing; and is frequently resorted to in summer, but is suitable also in autumn and spring for those who seek a change without being actually invalids. "Persons disposed to hypochondriasis and mental depression, and many old Indians with their somewhat complicated cachexia, without organic disease, derive great benefit from the cheering influences of this climate, which is also a very good change from Pau and Arcachon." It is not, however, suited for cases of nervous irritability or a tendency to hysteria.

Arcachon, also on the west coast of France, is inland 9 miles. It is protected from the west and south-west, and also from the east and south-east, by the dense pine forest in which it lies. A large basin of sea-water, connected by means of a narrow channel with the Atlantic, diminishes the coldness and dryness of the north and north-east winds which reach it. Its mean annual temperature is 58°, and its moisture 15° short of saturation, its rainfall being 32 inches and rainy days 103. The soil is sandy and dry. "The climate is mild and soothing, and is specially suitable to cases of irritable bronchial or laryngeal catarrh, to cases of phthisis with tendency to congestion or inflammatory complications, and to persons of nervous temperament." To persons of a relaxed habit of body it is not to be recommended. The season is from October to May.

The coasts of Norway, Sweden, and Denmark, the coasts of Holland, Belgium, and Germany, and the shores of the Baltic, are all rich in seaside summer resorts, the features of which are a highly bracing, stimulating, and tonic climate, sea-bathing, and more or less natural beauties.

Alpine climates have of recent years become exceedingly popular especially for the treatment of lung affections. The atmospheric conditions

in elevated situations have been already to some extent indicated in the early paragraphs of this section. The air is very pure, free to a very large, if not absolute, extent, of germ life, or if germ life is not absent the conditions are not favourable to its growth. This is a matter of very great moment in lung affections of a consumptive kind. Then the air is rarefied, because of the lower pressure; it is believed to be relatively drier; it is also colder, the degree of cold being dependent upon the elevation, but the heat of the sun is more intense. The effects of these conditions are experienced mainly by the heart, lungs, and skin. The action of the heart is increased, at first both in force and frequency, but latterly, as the person becomes accustomed to the elevation, the increased frequency disappears. The action of the lungs is also stimulated. The depth of breathing is increased, probably to compensate for the diminished amount of oxygen in the air, and the lungs are thus more fully expanded; the quantity of water and carbonic acid gas given out is increased. The digestion and appetite are improved; and on the skin a bracing and tonic effect is produced. Though the atmosphere is cold the tendency to take cold is lessened, perhaps because of the bracing effect of the cold on the skin, probably also because of the purity and relative dryness of the atmosphere. The whole effect is exhilarating, stimulating to improved general nutrition, which ought to be evidenced by gain of weight, increased elasticity of body and of muscular power. Perhaps the increased quantity of ozone in mountain air is a cause of the marked mental exhilaration. To the same cause has been attributed the sleeplessness which affects the majority of people at great elevations. The sleep is usually restless and filled with dreams for several nights after arrival. This, it is said, passes off at most in a week or two. But it has also been observed that less sleep seemed required, that a shorter than customary period seemed to suffice. On some people, however, mountain air has an effect conducive to sound sleep.

Mountain climates are eminently suited for conditions of depression due to mental or physical overstrain, with weak digestion, depressed nervous system, &c. For those recovering from acute disease, it is also advised as an active agent in quickening the process, and for those whose constitutions have been undermined by malaria, or by a residence in a hot climate, such as India. Chronic bronchitis with excessive expectoration may be expected to benefit, as well as cases of pure asthma, nervous asthma, particularly in the young or those not beyond the prime of life. Chronic catarrh of the throat and air-passages also yields to the bracing tonic influence of the mountain air, and relaxed conditions of the skin with excessive perspiration. The value of mountain climates for consumptive patients has of recent years been much discussed. Dr. Hermann Weber thus expresses his views:—"We cannot, therefore, hesitate to say that in a great many cases of phthisis and phthisical tendency, long residence in certain mountain climates is useful. Prominent among these conditions are: 1, tendency to phthisis, inherited or otherwise; 2, chronic catarrhal affections of the apex, or upper portion, of one or both lungs, without or with affection of the lung-tissue itself; 3, chronic bronchial catarrh of the lower lobes, with much secretion in young people, or, at all events, not in old people; 4, remains of pneumonia (inflammation of the lung); 5, remains of pleuritic affections, with and without exudation; 6, so-called caseous deposits, resulting from catarrhal, pneumonic, or pleuritic affections; 7, the early stages of phthisis in one or both lungs." "*We must add that phthisis, even in the earliest stages, ought to be excluded from European Alpine climates, when it occurs in persons with an irritable heart and circulation, with a constantly rapid pulse, whom the slightest derangement makes feverish, who are unable to bear cold and the slightest changes of temperature. . . . Further, patients with advanced and still progressive phthisis ought to avoid Alpine climates. It may be difficult to promise them a cure anywhere, but at the warmer health resorts of the Rivieras, Algiers, or Madeira, they have more comfort; while others, if they knew their condition, would prefer the sheltered localities near their own homes and friends. The same ought to be said to all those whose condition, if they were to go to the Alps, would be likely to keep them, during weeks and months together, indoors.*"

We have put these sentences in *italics* because many people cannot understand how a climate which has, without doubt, proved valuable in some cases of consumption, should not prove valuable to all, and because they emphasize the fact that it is in the early or only threatened stage of consumption that the climatic treatment ought to be resorted to. Many people when told they ought to leave business, professional duties, or household cares, for a change of air and scene, reply with the query, "Am I so bad as that?" Now it ought not to

be when the patient has reached a grave stage in the course of a disease that he is ordered away, but more urgently as soon as risk seems to threaten, in order to prevent the arrival of a serious change. To the entreaty of the doctor, how often does the patient answer in effect, that he really cannot leave his work at present, that he will wait for a season, that there are no urgent symptoms, and that if urgent symptoms do show themselves, he will then be prepared to sacrifice everything and go off. It is, therefore, necessary to insist that the beneficial effects of all climatic treatment, most certainly in consumptive affections, and specially treatment by mountain air, are obtained chiefly in those periods when the disease is inactive, either before it has actually broken out, or when it seems to be quieting down after an outburst, one might almost say obtained *only* then.

The cases *not suitable* for mountain climates are those of heart disease, aneurism, tendency to apoplexy, dilatation of the lungs (emphysema, p. 283), tubercular disease of the larynx or bowel, tendency to acute rheumatism, or to acute inflammation of the throat and tonsils, convalescence from dysentery, Bright's disease of the kidneys, and the forms of consumption already indicated. Patients with irritability of the nervous system, as well as those who, from whatever cause, general debility, &c., cannot bear the sudden change from the heat of the direct rays of the sun during the day to the cold frosty air of the night, or who need protection from the wind, should not try mountain resorts. The old and the very young come into the last class. We shall now briefly note four of the chief Alpine health resorts; the mountain health resorts of America and India are illustrated under their respective headings.

Davos Platz is the chief mountain resort in Europe for consumptives. Attention was directed to it in 1867 by Dr. Weber, since which time it has achieved a great reputation. It is situated in the Canton Grisons, Switzerland, at an elevation of 5140 feet above the sea. Upwards of 1300 invalids winter there. It may be reached on the evening of the third day from London, the journey passing by Brussels, Basle, Zurich, and Ragatz, the distance from Ragatz to Davos being accomplished by diligence. It lies in a valley 4 miles long, running parallel to the Engadine but in an opposite direction. It is sheltered during the winter, and its atmosphere is still and cold.

The winter season lasts from the middle of October to the end of March. The snow falls early in November and lies crisp and clear till April, when it begins to melt, at which time visitors leave, though a mountain retreat is in summer as beneficial as in winter, for those who can bear the more changeable character of spring weather.

During the day patients go out into the sunshine; the treatment being essentially a pure air treatment, the more lengthened the outdoor life the better. From 10 a.m. to 4 p.m. the warm sunshine lasts; after the latter hour patients return indoors where a constant temperature of 65° is maintained. The temperature outside may fall to 10°, 20°, or more below freezing. This is not felt unduly, because of the purity, crispness, and comparative dryness of the air. From the Platz there is an ascent through pine-woods to the summit of a mountain 1000 feet higher, and this affords admirable exercise in easy stages for those who can attempt it wholly or partly. There is also abundance of amusement in the shape of concerts, &c., during the season. What has been said as to the cases for which mountain air is suitable is fully applicable to Davos Platz.

St. Moritz, another Swiss resort, is in the Upper Engadine, 5710 feet above the sea-level. There is more wind here than at Davos, and it is consequently less suited for those very sensitive to movement of the air. Its temperature is rather lower than that of Davos, but, with the exception noted, it is suitable for similar cases. It possesses an iron spring, and bathing and drinking houses. Its scenery is magnificent, and it affords greater scope for excursions. In winter there is the additional attraction of skating on the lake of St. Moritz. These circumstances, with the presence of the mineral spring, make it more advisable than Davos for those who do not require the more complete protection against wind offered by the latter. Business and professional men, the patient suffering from dyspepsia, sluggish liver, depressed nervous system, &c., will find it exceedingly attractive and bracing.

Tarasp, in the Lower Engadine, may be reached in one day from Davos or St. Moritz. Its altitude is barely 4000 feet. Eight hundred feet above it, reached by a winding path, is the village of **Vulpera**. It is a summer resort, the season being from June to the end of August. It is possessed of a Spa resembling that of the Carlsbad Sprüdel, the waters of which are drunk between 6 and 8 a.m., three tumblers being the rule, with an interval of twenty

minutes' brisk walking exercise between each. It is not advised for consumptive patients, but for the dyspeptic, the victim of nervous depression and a slow liver, and the gouty.

Meran, in the Tyrol, may be reached from Tarasp in a journey by diligence of seventeen hours. It is well protected from the wind, lying sheltered in the Funster valley; and its winter climate is very equable. Its season begins in September. Consumptives resort to it for the "grape cure," which consists in consuming before breakfast three or four pounds of grapes. The patients, who employ the grapes, as others do waters elsewhere, for their action on the bowels, come out in the early morning (about 7·30) and slowly eat the grapes while quiet exercise is indulged in. A light breakfast follows. Consumptive patients are recommended to take the grapes after breakfast up till noon, and to eat them slowly, a pound being consumed. In this way they do not act upon the bowels as in the former.

Atlantic Islands Resorts.

Madeira is the type of warm and moist marine climates. The islands are situated in the North Atlantic, off the north-west coast of Africa, between 32° and 34° north latitude and 16° and 17° west longitude. Owing to the exceedingly equable character of the climate, Madeira was for a long time the chief resort of consumptives, but the moisture of the atmosphere has made it questionable whether it is really suitable for such cases. The chief place is Funchal. Its mean annual temperature is about 65°, the mean winter temperature being 61°, spring 62°, summer 69°·5, and autumn 67°. The lowest temperature is seldom below 48°, and the highest rarely above 86°, the range between day and night being about 9°. The degree of moisture is variable, between 70° and 74°, and the number of rainy days is 74. "Its rainfall in March is sometimes considerable, but from October to May you can always count upon an equable temperature, and weather at least as fine as a favourable June in England, and scenery which is among the most varied and attractive in the world." There are the daily sea and land breezes. The character of the climate is soothing and even relaxing. It is thus specially suitable for irritable conditions of the mucous membrane of the larynx and bronchial tubes, for chronic bronchitis with irritable cough and little expectoration, and for dilatation of the lungs. In early cases of consumption, in persons with excitable circulation, it deserves a trial.

The Canary Islands lie four degrees south of Madeira. The principal island is Teneriffe, extending 60 miles from north-east to south-west, 60 miles across at its widest part, and less than 16 miles at its narrowest, famous by its peak, which rises 12,000 feet above the sea-level. The capital is **Santa Cruz**, a town of 15,000 inhabitants, but its chief health resort is **Orotava** on the north-western side, reached from Santa Cruz by carriage in a few hours' drive. The town lies about 3 miles from the sea-coast and fully 1000 feet above its level, but the town of Port Orotava lies on a peninsula bathed by the Atlantic. The latter has become the most popular resort of recent years; and the following notes of the character of its climate are derived from letters written to the *British Medical Journal*, by the editor Mr. Ernest Hart, in 1887. The town lies on the brow of a hill, and behind it rise the mountain slopes of La Cumbra, "rising like scarped bastions to a height of 8000 feet."

The mean temperature of the year is 68°·5; between the hottest and the coldest month the temperature does not vary more than 14°, while in London it amounts to 26°·1, in Pau to 35°·8, in Madeira to 14°·9, in Algiers to 23°·5. The winter temperature is 63°·8, that of London is 41°·7, of Nice 49°·6, of Algiers 58°·3, of Madeira, 61°·7. "Moreover, it is not a mere lessening of the temperature, but quite another world. Neither at Nice, at Rome, at Naples, nor anywhere in France or Italy, can you dispense in the winter with fires at given periods of the day. I have felt it colder in going out after sunset along the Promenade des Anglais at Nice than almost anywhere else. I have shivered in a greatcoat in crossing the Libyan Desert in March, and twice I have passed through heavy hail-storms. On a dahabieh on the Nile ice will form on deck sometimes at night, so great is the fall of temperature after sunset. At Orotava, as Belcastel picturesquely puts it, a chimney would be ashamed of its perpetual nudity. There are none. Throughout the winter you bathe in the sea at Port Orotava, with as much pleasure as at Brighton in July." The extreme range of temperature during any one day during the six winter months does not exceed 5°·4, whereas even at Madeira it amounts to about 12°. "Orotava is not less remarkably favoured in respect to the singular dryness of the air, which makes it peculiarly valuable for a large class of invalids suffering from chest and throat affections, and in this respect it has an enormous

advantage over Madeira. The rainfall at Madeira is estimated at 29 inches, that of Teneriffe amounts on the average to 14·7 inches, so that Orotava is twice as dry." The average relative humidity of the air varies from 53 in December to 79 in August. The refreshing land and sea breezes play with perfect regularity, the Peak of Teneriffe cutting off the north-east wind or brisa. "In short all the conditions present make the climate an ideal one both for lovers of health and lovers of Nature. Orotava has the exceptional advantage of being quite free from mosquitoes, which cannot be said of Las Palmas and Santa Cruz. In the Canaries generally there are no poisonous snakes or venomous reptiles." "From one year's end to the other the variation of temperature does not exceed 18°, and this within the limits which are most favourable to life. That is the whole magic of this climate. There is no excessive heat in summer; no cold in winter. Very small rainfall, and that chiefly at night. No chill at sunset; no heavy dews; no frosts; no sirocco. It is a climate full of geniality with neither bite nor burn. A garden of flowers which bloom perennially. It has the charm of temperate zones, without their fluctuations and their drawbacks; the delights of southern continents without their pests, such as mosquitoes, venomous beasts, and insects, their excessive heats, their miasms, or their heavy rainfall." "Medically Teneriffe is of course peculiarly suited to that important and numerous class of invalids who suffer from affections of the lungs and of the air passages," from consumption in various stages, Bright's disease and diabetes. Of it Professor Jaccoud says, "The climate of Teneriffe is drier and more tonic than that of Madeira, and it is capable of completing and usefully extending the therapeutic applications proper to Madeira in a number of cases. It unites the advantage of mild and equable temperature with those of proximity to the sea, and with the advantages of mountain climates." For in summer one may betake one's self inland and up the mountain slopes to the town of Orotava already mentioned, where the temperatures are slightly lower in winter, and perceptibly so in summer, but equally mild and equable. **Laguna**, on the road from Santa Cruz to Orotava, "offers a summer climate which leaves nothing to be desired," and affords to those who need it a more bracing air. "There are the capabilities of a high mountain station which would rival Davos, but they are not yet developed by suitable residences for invalids. Thus Teneriffe seems to possess all the resources which could be desired for residents throughout the year. Its capabilities as a summer resort still await further development, and I believe that it is intended to arrange hotel accommodation near La Paz, at Icod, and at Laguna, which will be a great boon to those who desire to spend the summer months in Teneriffe. Meantime there is no small number of houses to be had which were built by the vine-holders and cochineal-planters in the days when these agricultural industries were a source of great wealth, which they have now ceased to be. These houses, built in the Spanish style and suitable to the climate, may be rented at present (1887) at very low rates. I heard of rents of furnished villas varying from £2 a month up to £10 a month, the latter being the rent of a beautiful villa with a delightful garden. The wages of servants are very low indeed, and their diet is most frugal; so that, at the present scale of prices, permanent residence in Orotava is as cheap as it is delightful and healthful. I cannot but think that it is destined to become the most favoured health resort for Englishmen, and indeed for Europeans generally." It may finally be noted that difficulties which existed in getting to Orotava have now disappeared; that the passage may be made from Liverpool to Teneriffe and back by African lines of steamers for the sum of £15, which includes maintenance on board steamer on the most liberal scale for the eight days' journey out and the eight days' journey back; and at Orotava there is now excellent hotel accommodation.

It may be that, as indeed has been said, Mr. Ernest Hart has presented too roseate a view of the delights of the climate of Orotava. At any rate it has a rival in its immediate neighbourhood, namely Las Palmas.

Las Palmas is a town having a population of 12,572, situated on the Grand Canary, an island nearly circular in shape, of a diameter of 24 miles. It faces the Atlantic on the east, and behind it the island rises abruptly to a height of 250 to 300 feet, stretching out as a dry barren plain for about 2 miles. The nearest point of the African coast is distant 120 miles. It is said to be more interesting than Teneriffe, and for visitors it possesses the advantage of a fine sandy beach, 4 miles long, with abundant opportunities for bathing. The mean temperature of the six coldest months, November to May, is 63°·10, the mean of the highest is 68°·53, the mean of the lowest 57°·27, and the mean daily range 10°·86. The moisture

of the atmosphere ranges from 54 to 70 per cent of saturation, and the annual rainfall amounts to 14 inches. "Las Palmas is favoured with a large amount of sunshine. The sun glows with great brilliancy, and pours down its life-giving rays through a sky of the most beautiful azure, making the air so luminous that everything looks bright and cheerful. Indeed all nature seems to rejoice in the sunny glory of Grand Canary, the most favoured of the 'Fortunate Islands.' The clear, pure, moderately dry air with which the 'gentle' trade-wind fans Las Palmas is very refreshing and invigorating." In summer the mountains offer a beautiful retreat from any undue heat. The climate is suited for consumptive cases, for chronic bronchitis, for diseases of the kidneys, for chronic rheumatism, and indeed for such cases as Orotava is suited for. "Although the daily range of temperature is slightly more than Madeira, this is more than compensated for by the tonic properties of the air, which is drier and bracing and illuminated by more brilliant sunshine. Las Palmas obviously possesses important climatic advantages over all of the famous health resorts of the south of Europe or the north of Africa. The invalid may be out in the open air all day long, and may sleep with his bed-room window wide open. Very rarely will he have occasion to remain indoors on account of rain." So writes Dr. Mordey Douglas, of Sunderland, who goes on to add, "During the seven months I was there I was only once prevented going out by rain. . . . Personally I have the greatest reason to be thankful that I sought the restorative influences of this splendid climate. I went branded with the ominous words 'no hope,' and have returned, as you see, a new man, with my health immensely improved. On the good opinion I formed of the climate of Las Palmas I did not hesitate to stake my life, and will do so again if necessary. And why should I hesitate, when after the most rigid and careful consideration I am forced to the conclusion that Las Palmas has the finest climate in the world of which we have any knowledge."

The Azores in Mid-Atlantic have a climate similar to Madeira.

African Health Resorts.

Algiers on the north coast of Africa has a climate of the general character of the districts on the Mediterranean shores, which sea is the chief influence in determining its exact nature. The mean temperature of the winter season, which extends from the end of October to the end of April, ranges between 57° and 62° Fahr., the daily range being about 12°, and during the same period the rainy days number between 45 and 65. It is exposed to the north-west wind, and suffers occasionally from the sirocco, hot and laden with sand from the desert, from which, however, the mountains afford considerable protection. The atmosphere is moderately humid. In early stages of consumption the climate is beneficial and in recovery from inflammation of the lungs. Bilious subjects do not benefit, nor is it suitable in Bright's disease. Sixty miles south-west of Algiers, 15 miles inland, and situated among the hills in the neighbourhood of pine-woods, are the hot springs of **Hammam R'Hira.** Here the air is drier and more stimulating, and moderately warm. October, November, and December are the best months, as towards the end of December, and in January, February, and March, it is rainy. Fair weather is again experienced in April and May. It is specially suitable for rheumatic and gouty patients. Hot saline baths are to be had and an iron spring for drinking.

Tangiers offers a delightful climate of the humid class, but mild and bright.

Egypt offers the most notable illustrations of a dry climate with heat. The air is dried by the desert, and owing to its clearness and freedom from moisture no screen is interposed to the rays from the sun. At sunset, however, radiation from the earth takes place rapidly and the nights are, consequently, very cold, with heavy dews. Thus while the mean temperature in December is 58°·5, the highest is 75° and the lowest 39°, showing an average range of temperature of 36°. The mean temperature for the four months December to March is 59°, and the mean daily range 40°. During these months the moisture of the atmosphere, as compared with June, July, and August in England, is as 56 to 81. Thus the marked feature of the climate is the dryness and clearness of the atmosphere, rain being practically unknown during the season. One notable effect of such a climate is its markedly stimulating action on the skin, the result of which is relief to deeper organs and specially the kidneys. In Bright's disease this climate offers benefits such as almost no other climate does; also in chronic rheumatism and gout and chronic catarrhal complaints, chronic bronchitis with excessive secretion. In early phthisis or in cases of consumption at other stages, but not active, the dry air of the desert

is beneficial, and may arrest the progress of the disease.

Alexandria owing to its proximity to the sea has a moist atmosphere, which renders its climate uncomfortably hot, even when the temperature is not above 70° or 75°. **Cairo** is an improvement in this respect, but **Heluan,** 14 or 15 miles south of Cairo, Luxor, Assouan, and the Nubian Desert are the chief localities. Cairo has, of course, all the advantages of a town, and all its disadvantages of polluted atmosphere and insanitary conditions also. Heluan boasts a hotel and bath-house, and, in the desert, tent life is the rule. The Egyptian season begins with November and lasts till March, later than which the invalid must not stay. The return home should not be direct, but might be by the Grand Canary or Teneriffe, the higher stations being chosen for a brief residence.

South Africa possesses many health resorts, mountain as well as by the sea. Of the latter are **Capetown, Port-Elizabeth,** and **Port Natal. Capetown** has a mean winter temperature of 57°, spring and autumn 64°, summer 71°. Its characteristics are moderate dryness and warmth and the stimulating effect common to most coast places. Wind and dust are the drawbacks. In the interior the atmosphere is very dry.

In the interior **Bloemfontein** is the best-known place, being situated 4700 feet above sea-level, but **Pretoria, Heidelberg,** and many other places in the Transvaal are held in repute. The long journey by ox-wagon is the great objection to seeking these localities.

American Health Resorts.

It is not our object to do more than indicate a few of the leading features of some of the principal resorts in America recommended in recent years, and specially for those suffering from diseases of the lungs of a consumptive kind.

San Diego lies on the sea-board of California, fully 500 miles south of San Francisco, and just about the border of Lower California. It lies on a slope facing a bay, the bay of San Diego. The slope extends inland about a mile, gradually rising to a height of 200 feet, and is succeeded by a rolling table-land stretching for miles inland. The bay is formed into a natural harbour by a peninsula that stretches out a long protecting arm between it and the Pacific, the arm spreading out at its termination to an area on which is built the city of Coronado. At the end of 1887 the population of San Diego was 25,000; two years before it was not more than 4000. The people seem to be fully alive to the possible future of their city, and provision for effective drainage and water-supply has already been made.

As to the climate of San Diego, its mean summer temperature is 66°·7, the mean highest summer temperature is 88°·6, the mean of the lowest winter temperatures is 54°·4, the mean annual temperature being 60°·5. The relative humidity of the atmosphere is 72·9 per cent of saturation. Between the mean day temperature and that of the night in the month of January for twelve years the difference was only 13°, and the difference between the day and night temperatures for July was only 9°. The winter temperature never falls below 32°, and in ten years reached that point twice only. The atmosphere is rarely burdened with fogs, and blizzards are unknown, though hot dry winds from the desert blow occasionally, more frequently in winter. There are daily land and sea breezes, which blow for about three-fourths of the year with unfailing regularity, the remaining time being occupied by rain winds, which come from a southerly or south-westerly direction, and calms. "The great mountain range of California, the Sierra Nevada, practically terminates in San Diego County, while the foot-hills and elevated table-lands are continued into Lower California. The various peaks of Julian, Cuyamaca, Laguna, Palomar, Greyback, San Jacinto, &c., vary from 5000 to over 10,000 feet in height, and unite to make up the picturesque landscapes for which the county is so famous. These mountains are thickly wooded, and throughout the year covered with rich verdure, whose balsamic exudations from pine, hemlock, tamarack, &c., give a special character to the atmosphere. The climate is exceedingly dry and bracing, with an abundance of warm sunlight in winter and refreshing coolness in summer. . . . The highest elevations are seldom visited by invalids, inasmuch as the desired relief is generally obtained by a sojourn at lower levels. . . . During the summer, however, there is nothing so enjoyable as a trip to these mountains; and, as game is everywhere abundant, it is a paradise for hunters and camping parties."

The climate is suited for some classes of consumptives, for those suffering from malaria, for catarrhal conditions of the throat, nose, and air-passages, for asthma and hay-fever, a more or less dry air being obtained as the invalid retreats upwards and inland, or keeps near the coast-line. In summer the consumptive is advised not to remain below an altitude of 2000 feet,

while in winter he may venture as far as the coast. In the valleys and in the elevated back country there are various small towns, such as San Jacinto, Elsinore and Linda Rosa, where hot sulphur bathing is to be had, so that the invalid has a choice of locality for his particular complaint.

San José is the principal town of Santa Clara County, California. It is 50 miles south of San Francisco, and with suburbs numbers 25,000 inhabitants. The western boundary of Santa Clara County lies 20 miles inland from the Pacific coast. "The county consists of a level valley varying in width from 6 to 18 miles, bounded on the north by the county of Alameda and Bay of San Francisco, extending south-easterly a distance of 50 miles and girt on either side by rolling hills and mountain ranges." The highest mountain summit, 4443 feet above sea-level, is Mount Hamilton, which is crowned by the Lick Observatory "with the largest telescope in the world." The mean temperature of this region is about 70° in summer and 55° in winter. In winter the lowest temperature is rarely below 30°, and this lasts only a brief period. "The average annual rainfall for twenty years was 16·17 inches. There is no rain during the summer, and the country after harvest, when the hills are brown and dusty, presents the most unprepossessing appearance." January and February are probably the best months, and in the hottest months of the year the mountains offer a refuge.

The climate, like that of San Diego, is equable and mild, with an atmosphere moderately humid and, therefore, resembling the warm moist climates of the Mediterranean.

Denver, Manitou Springs, and **Colorado Springs** in Colorado among the Rocky Mountains are the chief health resorts, at present, in America for the treatment of consumption.

Denver lies at an altitude of 5200 feet, and in 1880 had a population of over 30,000. Its situation is thus described by Dr. Denison:—"As seen across the plains from the city, the mountains, which residents of Denver and Colorado generally consider their own peculiar heritage, present a magnificent appearance. Apparently only 2 or 3 miles distant—owing to the wonderful clearness of the atmosphere—they are in reality 12 or 15 miles away, and seem to sweep around the city in the segment of a circle, in three tolerably distinct tiers, from Long's Peak, 50 miles north, to Pike's Peak, 80 miles south. The foot-hills, the first tier, rise two or three thousand feet above the plains, seamed with cañons and gorges, or dotted with sunny pastures; the second tier rises still higher, and more indistinct, while above all, the glistening peaks of the snowy range rise 13,000 or 14,000 feet into the intense blue sky."

Manitou Springs, Colorado, lies, at an elevation of 6370 feet, 75 miles south of Denver and 6 miles west of Colorado Springs, in a little valley sheltered on three sides by the hills. Running through the valley is Fountain Creek, upon the banks of which are the springs, six in number, on account of which the place is named. "Long before the medicinal virtues of the springs of this region were known to the white settlers, the Indians of the Rocky Mountain tribes were accustomed to bring hither their sick and afflicted to drink of and bathe in these waters, appropriately applying the name 'Manitou,' or 'Great Spirit,' to an agency of relief they deemed supernatural." These springs with their picturesque surroundings, and tonic atmosphere, yearly attract many invalids to Manitou, which is rapidly gaining favour, both as a summer and winter resort. In his *brochure* upon the mineral waters of this locality, Dr. S. E. Solly remarks: "The Manitou and Navajoe have been highly praised for their relief of old kidney and liver troubles, and the Iron Ute for chronic alcoholism and uterine derangements. Many of the phthisical patients who come to this dry bracing air, in increasing numbers, are also said to have drunk of the waters with evident advantage."

Colorado Springs is 6 miles from Manitou, and its altitude is 6000 feet.

The temperature, relative humidity, and rainfall in inches are shown in the following table:—

	Denver.	Manitou and Colorado Springs.
Mean Spring Temperature...... ..	47°	45°
,, Summer ,, ...	71°	68°
,, Autumn ,, ...	50°	48°
,, Winter ,, ...	29°	28°
,, Annual ,, ...	49°	47°
,, Relative Humidity (p. cent)	46	49
Yearly Mean Rainfall (in inches).	16	15

This table shows that at these resorts there is considerable variation of temperature at different seasons; and there is also a considerable difference between the sun and shade temperatures, and between day and night. This of necessity arises because of the great clearness of the air, permitting the sun's rays to be felt in full force during the day, and the absence of cloud permitting rapid loss of heat with sundown. In summer the neighbouring hills offer

retreats from the excessive heat, camping out in tents being resorted to. The chief feature of the atmosphere is its dryness, and Dr. Denison concludes that *cool dry* climates are better adapted to the needs of consumptive patients than warm climates with moisture, or even warm dry climates, and it is to these features of the atmosphere of the Rocky Mountains that he assigns the curative influence. Asthma, inflammatory cases of consumption, and cases attended by bleeding from the lungs, in the early stage, are those which he believes to be best suited to such high altitudes; while those complicated with heart affection and chronic bronchitis he believes unsuited. Finally he concludes that "a somewhat *prolonged residence* is essential in the climate in which a certain consumptive finds his disease arrested; and a partial recovery generally necessitates a permanent residence, the return to the locality of the origination of the disease, except temporarily, being generally regarded as a dangerous procedure." Those who wish to study Dr. Denison's very full discussion of the subject will find it in his *Rocky Mountain Health Resorts*, published in 1880.

There are other resorts in America of a nature similar to those in Colorado, which cannot be discussed here, **Santa Fé**, 7000 feet above the sea-level, in New Mexico, and in South America among the Andes are similar resorts, such as **Santa Fé de Bogota** (8648 feet), **Quito** (10,000 feet), &c. The former has a remarkably equable temperature, 59° Fahr. in winter, and 59°·5 in spring and summer. Of the South American resorts, Dr. Weber says: "In no other climate have we witnessed such good results on our patients as in the Peruvian Andes; but the distance from home is great, and some invalids find it difficult to accustom themselves to Spanish, or rather Peruvian-Spanish, habits of life." He speaks specially in reference to **Jauja** and **Huancayo**, the health resorts for consumptive patients from Lima in Peru.

Florida as a health resort has come into prominence within the last ten or twelve years. The northern extremity of the state, bordering on Georgia and Alabama and forming the north-eastern shore of the Gulf of Mexico, will naturally differ in climate from the middle division of the state, washed on the east by the Atlantic and on the west by the waters of the Gulf; and this middle division will again vary considerably from the extremity of the peninsula, not only because the latter is nearer the tropics, but also because round it sweeps the warm current of the Gulf-stream. The easterly winds, warm from the Gulf-stream, keep the eastern or Atlantic coast of Florida warmer by more than 1° than the Gulf coast, making the winter climate of the former milder and more equable than the latter. In the northern division the extremes of temperature are 105° and 20°, in the middle division—the Orange Belt—they are 100° and 25°, and in the extreme south 95° and 30°. These, it is to be noted, are *extremes*. In the middle division the climate is characterized by remarkable equability, freedom from sudden change and marked cold, and not subject to excessive heat. Frost sometimes occurs; when it does, great damage is done to orange culture, as in the cold snap of 1886. A remarkable feature of Florida is the enormous number of inland lakes, said to number certainly 1200 fresh-water lakes, the largest of which, Lake Okeechobee, has an area of 1000 square miles, and the smallest less than 100 square feet. Lake Okeechobee is at the northern border of the southern division of Florida, and south of it there extends an enormous tract of marsh, filled with islands, called the Everglades, or in Indian, "Grass Water." These Everglades cover an aggregate area of fully 7500 square miles; the water varies in depth from a few inches to several feet, rarely more than ten. "Tall grass, as high sometimes as 8 or 10 feet, is very common, with shrubs, vines, trees, moss, and all sorts of tangle and roots. Islands lie here and there, with trees and vines on them—cypress, pine, oaks, palmettoes, magnolias, and a score at least of other sub-tropical trees. Fish in infinite variety abound everywhere." The waters are not stagnant and foul, but clear and pure, and said to be even drinkable. In the rainy season, July to October, the Everglades are impassable. In 1881 a company began operations to reclaim by drainage this submerged land in the neighbourhood of Lake Okeechobee, already with considerable success. It is this enormous area of water-covered land, along with a coast-line of nearly 1200 miles, that is the main factor in producing the singularly equable climate.

One of the chief health resorts is **Jacksonville**, on the St. John's River, a few miles from the coast, not far from the northern boundary of the state. Its proximity to the Atlantic confers on it a climate characteristic of that of the mid or semi-tropical division of Florida. Its mean temperature for the year 1887 was 68°·1, the maximum 100°·3, and the minimum 21°·9. The mean winter temperature is said to be 60°, and

the summer 80°, while the mean relative humidity for the five months, from November to March, is 68·8 per cent of saturation.

St. Augustine, on the coast, 36 miles south of Jacksonville, the oldest city in the United States, and "noted for its picturesque beauty," is a favourite resort. **Key West**, on one of the multitudinous islands of the Florida Keys, the whole area of which is 12 square miles, is another of the favoured resorts. Its mean relative humidity for the months November to March is 76·8. On the Gulf coast from **Cedar Keys**, 127 miles south-west across the peninsula from Jacksonville, down southwards past Punta Rassa, on to Monroe County and the Ten Thousand Islands, is a coast-line offering a suitable climate for a winter health resort, though, as already stated, fully a degree lower in temperature than localities of a similar latitude on the Atlantic coast. **Punta Rassa** is 200 miles south of Cedar Keys and 100 north of Cape Sable. Its mean annual temperature is 73°·4. The lowest monthly mean temperature—that of December—is 64°·5, the highest monthly mean temperature—that of July—is 81°·3. Its mean relative humidity for the winter season—November to March—is 72·7 per cent. Along this coast there are numerous harbours, visited by coasting steamers, where accommodation for travellers is now being provided.

The mid division, then, of Florida is the one which offers the chief advantages to the traveller for pleasure and the seeker after health. As a winter climate it is remarkable for warmth, equability, and moderate dryness. The state of Florida is said to be the healthiest in the United States. The U.S. census reports give the deaths from consumption as equal to 58 out of 1000 from all causes, while in New York State the number is 168, in California 138, in Maine 258. As to malaria it is doubtless to be found in the marshes of the Everglades, but not upon the coast.

Florida offers a unique climate for the sufferer from general ill-health, who is still not the victim of any particular disease. Not only does its equable and moderately dry climate offer unusual opportunities for an out-of-door life, but its varied and luxuriant vegetation, the semi-tropical character of its scenery, its inland lakes, its coast-line, the antique aspect of some of its towns, all bring to the utmost that powerfully healthful influence to bear on the depressed spirit and broken-down nervous system, which is summed up in the phrase "change of scene." Sufferers from lung diseases and consumption are also sent there. It is suited to them, *if the disease is not advanced.* If they seek and are capable of an out-of-door life, free from sudden and extreme changes, where they may lead an existence not of chronic invalidism but of active work, it is a suitable climate. But patients ought not to be sent there as a last resort, nor in the desperate hope of arresting a disease already far advanced. The climate of Florida is indeed fitted for such cases as have been described as benefited by the Riviera resorts of the Mediterranean. While we have noted the kind of consumptive cases for which it is beneficial, we remark that it is yet probably excelled for such cases by the drier air of mountain resorts.

The Bahama Islands, or Lucayos, lie to the south-east of Florida, and are washed by the waters of the Gulf-stream. Of the twenty-nine islands New Providence is the most populous, and contains the capital, Nassau. The lowest mean monthly temperature—that of January—is 70°, and the highest—that of July—82°. Equability is therefore a notable feature of the climate. From November to April, the winter season, the climate is most agreeable, and the rainfall is small. The mean relative humidity for the five winter months is 73·2. New Providence was held in repute as a climate for consumptives, but lung affections are common among Africans and the coloured race, and among the black troops, stationed at Nassau, the proportion invalided from this disease was very high. Those for whom Madeira is recommended would probably find the Bahama Islands still better, because of their greater equability of temperature.

Bermudas or Somers Islands, situated in the Atlantic, 600 miles east by south of Cape Hatteras, are another winter resort for America. The mean temperature is 70°, maximum 85°·8, and minimum 49°. They afford, therefore, a warm, equable, marine climate. They have been subject, however, to four attacks of yellow fever in the last thirty years.

Indian Health Resorts.

The Hill Stations of India are resorted to as an escape from the exhausting influence of the heat and the malaria so common on less elevated ground. Of these stations Sir Joseph Fayrer speaks as follows: "In the absence of organic lesions in important organs, such as liver, alimentary canal, lungs and heart, &c., the tendency to recurrence of the periodic forms of fever caused by malaria is lessened or prevented

by a sufficiently prolonged change to the hill sanitaria, whilst the whole system is remarkably reinvigorated. For such invalids and convalescents they are invaluable, though not quite equal to the more radical relaxation and change of climate involved by two long sea voyages with a more or less protracted sojourn in this country, or in some of the other salubrious localities of Europe. When, however, there has been developed any marked structural disease of the cerebral, thoracic, or abdominal organs, or even when, without any discovered or discoverable mischief of this nature to these parts, the blood, the digestive and nervous systems have become seriously impaired or damaged, experience has shown that removal to Europe is absolutely necessary to check the further downward progress and to secure convalescence. For such cases the hill climates are not suited. Moreover, it sometimes happens that invalids who have been weakened by heat and malarious fevers on the plains are liable to suffer from hill diarrhœa, especially at Simla, due probably to their previous enervated condition, diminution of air pressure, suppression of the action of the skin, bad water, and bad sanitation." Dr. Parkes believes it is because of the last two causes that such diarrhœa arises, and not simply because of the effect of the higher elevation, and specially because of unwholesome drinking-water. Among the stations named by Dr. Parkes are Darjeeling, Simla, Landour, Murree, Kussowlie, Nainee Tal, Dugshai, and Subathoo in the Bengal Presidency, the resorts of the Nilgherry range, Ootacamund, Wellington, Coonoor, Kotagiri in the Madras Presidency, and Mount Aboo, Mahableshwur, and Poorandhur in the Bombay Presidency. The first range from 4000 to 8000 feet above the sea-level, the second from 5000 to 7000 feet, and the third from 4000 to 4700 feet. If **Simla** be taken as an illustration, its lowest temperature is given by Parkes as 40° in the shade, and its highest as 80°, in June, with a total rainfall of 70 inches on an average. The fall is greatest in July and August, but from May to September the air is moist, and clouds and fogs are common. It is unsuited to the consumptive and to those with disease of heart or liver. Hill diarrhœa is common; and those liable to bowel complaint should seek some other station. It is believed to be free from malaria, and those weakened by such attacks, or in depressed health from overwork, &c., but otherwise sound, find it beneficial.

Murree, in the Punjaub, at an elevation of 7507 feet, has a temperature of 71° in June, the hottest month, and 36°·7 in January, the coldest, with an annual rainfall of 58·44 inches. It is well suited for Europeans who do not suffer from organic disease.

Landour and **Mussoorie**, in the North-west Provinces, the former over 8000 feet, and the latter nearly 7500, with a temperature of 70° to 74° in June, and 40° to 42° in January, the hottest and coldest months respectively, are also recommended as stations for those affected with malaria, and consequent disturbance of general health, but not where organic disease of heart, lungs, liver, or bowels exists.

Darjeeling, at an elevation of 6912 feet, situated in Sikkim, is said by Sir Joseph Fayrer to be, perhaps, the most salubrious of all the Himalayan sanitaria, and much of this is due to the comparative equability of its climate. Its highest mean temperature is in June, 63°·3, and its lowest in January, 39°·2; the rainfall is 118·24 annually. "Even very weakly children transported thither from the malarious plains soon become firm, plump, and rosy." In organic disease it is more beneficial than any of the other stations, though its chief benefits are derived by those suffering from functional disturbances only.

The **Nilgherry stations, Ootacamund** (7000 feet), **Coonoor** (6500 feet), **Wellington** (6200 feet), and **Kotagiri** (6500 feet) in the south-west of India, are called the Queen of Indian Sanitaria. Of them Fayrer says, "In the Nilgherries the invalid may exercise a choice of climate, not possible, in anything approaching an equal degree, at any of the other sanitaria brought under notice in this brief resumé. He may select Coonoor for its mildness, warmth, equability, and scenery, to prepare his constitution for the cooler and more bracing climate of Ootacamund; or, if his case indicate such necessity, he may remain there during his sojourn in the hills; or, to escape the south-west monsoon, its discomforts and disadvantages, he may find a pleasant and congenial refuge at Kotagiri, where its depressing influence is only experienced in a much mitigated degree. And when the north-east monsoon prevails at Kotagiri, from October to January, he may exchange residence there for Coonoor, where its force is only slightly experienced, or for Ootacamund, where it is not at all felt. The general experience of the many able physicians who have practised at these sanitaria tends to the conclusion that, whilst they are, at suitable seasons, particularly during the winter and hot months, eminently restorative

in cases of ill-health, caused by the heat and malaria of the low country, exhaustion of nerve energy, indigestion, portal plethora, and malarial fever, uncomplicated with visceral disease of a serious character, they are not advantageous to those afflicted with liver disorder, dysentery, phthisis, cardiac (heart) and brain disease. To those of all ages already in possession of sound physical and mental health, the Nilgherries, whether for temporary or permanent residence, stand out conspicuously as the most salubrious of all the known mountain climates of India. The children of European parentage, who remain all the year round, during the period set apart for educational training, are remarkably robust and healthy."

Mahableshwur, at an elevation of over 4500 feet, in the Western Ghats mountains, south of Bombay, is the summer residence of the Bombay government. Its season is from October to June. Between June and September is its rainy season, when the climate is hurtful to cases of rheumatism and of organic affections of lungs, bowel, liver, and heart.

Mount Aboo in Rajputana has an elevation of nearly 4000 feet. Its lowest mean temperature is 54°·2 in January, and its highest 77°·9 in May. June to September are its rainiest months.

We quote from Sir Joseph Fayrer, one of the highest authorities on the climate of India, the following practical rules: "Those who select India for a career should be in the enjoyment of fairly good physical and mental health. . . . The European should, if possible, make arrangements to arrive in India, at or near the commencement of the cold weather, or, at any rate, before its termination—say in November, and not later than January. The trying heat of the Red Sea, during the outward journey, is thus reduced to a minimum; and the transition from the autumn or early winter of this country to the genial cold season in India is found to be pleasant and healthful, whilst time is allowed, as the hot weather gradually approaches, for the partial accommodation of the constitution to the altered circumstances involved in the transfer from a temperate to a tropical climate. If, however, this is impracticable, the second best season for arrival, at some parts, under the influence of the south-west monsoon, is during July and August. But, in the event of this period being fixed upon for the voyage, the utmost care, in diet, drink, and clothing, must be taken to neutralize or mitigate the heat of Egypt and the Red Sea. Under such conditions, precautions must be had recourse to, to avoid anything like constipation, whilst the strictest abstinence from too highly seasoned food and alcoholic liquors must be enjoined. To time the arrival in India in April, May, and June—the hottest months—or during the latter half of September and most of October—the malarious season—is often to sow the seeds of cerebral (brain) and hepatic (liver) disease, which may give considerable future trouble, embitter subsequent residence, and foster an ineradicable dislike to the country. No one in delicate health, or who is not strong and vigorous, should be advised, or permitted to select these months for the commencement, or continuation of an Indian career."

"May and June, the hottest months, are not suited for leaving India, although some still do so, at the beginning of the former month, because it enables them to arrive in England in summer. But to the strongest, the voyage at this season is very trying—often to those in infirm health, fatal, especially in the Red Sea. . . . The danger is immensely increased by intemperance in eating or drinking. So it is in a journey across India, and thence to this country, in May or June. The climate of India during November, December, and January is so agreeable and salubrious that few who can remain leave it during these months." "February and March are the best months for embarkation, from any of the three principal Indian ports, especially for invalids, ladies, and children. The railways and inland river steamers now render it possible to reach these places, with expedition and punctuality, from the most remote districts. With sufficient forethought as to clothing and provisions, the longest railway journeys may be undertaken at this season in comfort and safety. . . . On starting from India, provision should be made for abundance of the warmest woollen and other clothing, to be utilized in the Mediterranean perhaps, the Atlantic and the Channel. Too much care cannot be exercised in thus securing the invalid, as well as those who are apparently in excellent health, against the evil effects of chill. Yet such a simple and self-evident precaution is too often neglected, and bronchitis, congestion of the liver, and recurrences of malarial fever are often the result, all of which might have been avoided. Those who are suffering from serious tropical diseases, or who have not recovered sufficiently from their effects, will do well to dally at any of the health resorts of the Mediterranean which

may have been recommended as suitable, and refrain from coming to England, until the month of June. Before this, the climate is usually unfavourable to recovery from chronic dysentery, malarial enlargement of liver, malarious cachexia, and tropical anæmia. Whereas, in conjunction with the appropriate treatment which can be commanded from English physicians practising at the southern sanitaria, sufferers are generally benefited by a stay there, until it is safe for them to proceed home. By the adoption of this course, the good effects of removal from the Indian climate and the sea voyage are maintained, and the chances of permanent restoration to health, after arrival in England, materially promoted."

Australian Health Resorts.

In these paragraphs we shall make some brief references to the climatic conditions in Australia, Tasmania, and New Zealand. Australia embraces a superficial area of 3,038,400 square miles, its greatest length from east to west being about 2500 miles, and from north to south about 1800. Moreover, one-third of it is in the torrid and the remainder in the south temperate zone. Tasmania, to the south of Australia, has an extreme length and breadth of 200 miles. New Zealand consists of two principal islands, about 1200 miles south-east of Australia, the united length of which, extending north-east to south-west, is 1163 miles, the mean breadth being 140 miles, and the total superficial area about 95,000 square miles.

We have put down these figures as explanatory of the fact that one cannot speak of the climate of Australia or New Zealand as if there were one prevailing kind of climate.

The seasons are: spring in September, October, and November, summer in December, January, and February, autumn in March, April, and May, winter in June, July, and August. The summer months are the months to be avoided, and the genial weather as a general rule begins about the last month of autumn and lasts till the middle of spring.

On the eastern side of Australia the northern portion is Queensland, the southern extremity is Victoria, and between the two is New South Wales. For purposes of convenience we have selected the chief towns of these divisions—Brisbane the chief town of Queensland, Sydney the chief town of New South Wales, and Melbourne the chief town of Victoria. The western side of Australia is called Western Australia, and we have taken Perth as illustrative of it. Between these eastern and western portions of Australia is a middle division, the southern part of which is South Australia, with its capital Adelaide. Hobart Town we have taken as representing Tasmania, Auckland as representing the northern island of New Zealand, and Christchurch and Dunedin as representing the southern island.

We have arranged these towns in a table, and have placed in columns the chief meteorological facts as to temperature, rainfall, &c., that we have been able to obtain.

	Queensland.	New South Wales.	Victoria.	South Australia.	Western Australia	Tasmania.	New Zealand (North).	New Zealand (South).	
	Brisbane.	Sydney.	Melbourne.	Adelaide.	Perth.	Hobart Tn.	Auckland.	Christchur.	Dunedin.
Mean Annual Temperature, ...	70°	62°·4	58°	63°·2	65°	54°	59°·54	52°·88	50°·72
Highest Mean Monthly Temperature, ...	...	73°·04 Jan.	66° Jan.	73° Feb.	79° Feb.	61° Jan.	69° Feb.	...	...
Lowest Mean Monthly Temperature, ...	...	53°·24 July	48° July	51° July	53° July	45° July	51° July	...	...
Mean Daily Range of Temperature, ...	...	14°·7	...	...	...	16°	17°·82	17°·10	13°·68
Average Annual Rainfall, ...	50 in.	48·697 in.	26 in.	21·091 in.	33 in.	21 in.	51·84	25·536 in.	31·682 in.
Average Annual Rainy Days, ...	128	141	137	114	111	189	179	...	...

Brisbane is situated in the southern portion of Queensland. Its mean temperature is like that of Madeira. The winter season, from May to November, is the best of the year. Frosts are occasional, though not severe. The air is moderately moist, and the changes of temperature not so marked as farther south. The prevailing winds are from the south, cooling breezes in the southern hemisphere. Northwards from Brisbane the climate becomes more tropical in character. Westwards from Brisbane, inland that is to say, are several health resorts, situated at considerable elevations, and with a drier atmosphere in proportion to their distance from the coast. For example, **Dalby** (1123 feet above sea-level) is 152 miles west of Brisbane, in the district of the Northern Downs; **Harlaxton** (2003 feet) is 78 miles from the coast and

98 miles west of Brisbane. Its mean maximum summer temperature is said to be 82°, and in winter its temperature rarely falls below 32°. **Killarney** (1691 feet) is 73 miles from the coast and 194 south-west from Brisbane, and **Mount Perry or Tenningering** (2500 feet), 60 miles from the coast and 200 north-west of Brisbane, amid beautiful mountain scenery. All these resorts are recommended in lung affections, consumption, asthma, and such cases of bronchitis as need a moderately dry and bracing atmosphere. **Toowoomba** (1921 feet), 100 miles west of Brisbane, 80 miles from the coast, in the district known as the "Garden of Queensland," that of the Darling Downs, is recommended in convalescence from malarial fevers.

Sydney.—The winter season at Sydney is June, July, and August, and is generally very cold, mornings and evenings being chill and disagreeable. July is the coldest month, and the temperature may fall to nearly 42°. In the interior of New South Wales ice of slight thickness is occasionally met with. Dew is heavy and fogs are common on low-lying situations. The spring months are pleasant and clear. The heat of summer is moderated by the sea and land breezes, the period when the sea breeze dies down in the evening and before the land breeze begins being one of considerable oppression. The unpleasant feature of the summer is the occurrence of hot dry winds from the north-west, which occur, on an average, four times every summer, though they last not usually longer than twelve hours, during which time the thermometer may rise to 90°, 100°, and even higher. These winds suddenly change to a violent southerly wind, which is attended by a rapid fall of temperature and usually some rain. The temperature in one half-hour, while this change is in progress, may oscillate through a range of 20° or 30°. These rapid changes make the climate very trying to anyone with lung affection. The relative moisture of the atmosphere varies between 67·5 and 77·5 per cent of saturation, and is highest in autumn.

West from Sydney on the Blue Mountains are health resorts, suitable for the more trying months of summer. Such are **Bowenfels**, nearly 3000 feet above sea-level, 78 miles from the coast, and 97 west of Sydney, **Katoomba** (3349 feet), 66 miles west of Sydney and 58 from the coast, the summer temperature of which seldom exceeds 75°, **Lawson** (2399 feet), 58 miles west of Sydney. Beyond the Blue Mountains are **Bathurst** (2153 feet), 145 miles west of Sydney, with a mean annual temperature of 56°·8, and **Goulburn** (2071 feet), 134 miles south from Sydney, with a mean annual temperature of 55°.

Diseases of the lungs are common among those belonging to Sydney, chiefly among the young of both sexes. This, it is said, is due mainly to the sudden changes to which the temperature is subject, as already noted. Dysentery is also common. Infectious diseases of children are practically unknown. Sydney is, therefore, not recommended in advanced disease of the lungs. But the climate is so healthy and delightful, except in the three hot months when the north-west wind occurs, when, however, escape to higher regions is possible, that for those who, though not advanced in consumption, have yet a consumptive tendency, but who must find a residence in a town where employment is to be had, Sydney is one of the places to be named, though Tasmania is held in higher repute.

Melbourne, the capital of Victoria, was formerly held in repute as affording a suitable climate for consumptive patients. It is in winter colder than the localities already named; and it is liable to sudden and uncertain changes of temperature throughout the year. It is also subject to hot winds from the north and storms of dust, very injurious to any suffering from lung affections, and the deaths from consumption are now nearly as numerous as in large towns in England. December, January, and February are the hottest months, and July is the coldest. The hot winds of summer are followed by strong breezes from the southward, which cause a rapid fall in temperature, amounting to 20° or 30°. In autumn "cool winds, Italian skies, gentle rains (at night) and a bright clear atmosphere, impart a spirit of strength and activity to the inhabitants which is not surpassed by any country in the world." Mountain resorts are also within reach of Melbourne, principally to the north-east. **Beechworth** (1795 feet) is 171 miles north-east, with a temperature in December of 67° and in July of 40°, and is more suitable for chest affections than Melbourne itself. **Ballaarat** is 100 miles west, at an elevation of 1427 feet, and is a noted resort for invalids. Its December temperature is 60°, and its July temperature 42°, and its air is bracing and moderately dry. **Ballan**, 45 miles north-west, has mineral springs, used for digestive complaints and kidney affections. **Alexandra**, 90 miles north-east, is suited for lung and kidney disorders. It lies amid a mountainous country, at an elevation of 1000 feet. **Charlton**, 173 miles north-west, is much more equable,

free of the sudden changes of temperature of Melbourne, and more fitted for consumptive patients.

Adelaide, the capital of South Australia, is 7 miles from the sea, has a milder temperature and more equable climate than Melbourne, but is inferior to Sydney and Tasmania for consumptives. December, January, and February are the hottest months and July the coldest. But the air is dry, and though in midsummer the temperature stands sometimes at 100° in the shade, the dry air renders it more tolerable than it would be in a moist atmosphere. Between April and October is the pleasantest season. In summer the hot north winds blow "like the blast from a furnace," accompanied by fine dust in clouds. Lung affections are common, and diarrhœal diseases.

Perth is the chief town in West Australia, a portion of the island said to be the healthiest of the Australian colonies. The table on p. 806 indicates a higher mean temperature than that of any of the other towns named, with a very hot summer. Its hottest month is February and the coldest are July and August, in which months the greatest rainfall occurs. The best season is from October to April; and the hot winds, which plague Melbourne and Adelaide, are not here so frequent or so severe. Western Australia, according to Mr. Ferguson, the colonial surgeon, has a death-rate of 12 per 1000, against 15 per 1000 for New South Wales and Tasmania.

Hobart Town is in the south of Tasmania. Tasmania has, on account of its smallness, a more marked insular climate than Australia. It is much more equable. Even in the height of summer the evenings and nights are cool and refreshing, and in winter the cold is never very great, not more severe, it is said, than that of the south of France. December, January, and February are the summer months, and the three following autumn months are the most enjoyable of the year. "The sky is then clear and serene, the days moderately warm, and the evenings and nights mild and genial." The north-west wind, which occasionally blows in summer, does not last long, though its heat and dryness are still unpleasant. The equability of the temperature make Tasmania more desirable for those suffering from lung affections than any of the Australian towns, though the comparative moisture of the atmosphere renders it still inferior to the high mountain altitudes of Central Europe, or of North and South America, for consumptives. It is very suitable for those exhausted by hotter climates.

Auckland, in the north New Zealand island, exhibits in its temperature (see table on p. 806) the chief characteristics of the New Zealand climate, equability and geniality. It is temperate also, and somewhat moist, the northern island being warmer than the southern.

Christchurch and **Dunedin** show the lower temperature of the southern island, though their range of temperature is not greater than that of Auckland, and if colder they are also equable. On the west coast of both islands the climate is less changeable than on the east coast. The rainfall on the west coast of both is very much greater than that on the east. Thus while at Christchurch on the east it is 25½ inches, at Hokitika, nearly opposite on the west coast, it is 112 inches. North-west winds prevail in the winter months and south-east in summer, but the hot winds are absent. The winter is severe at Christchurch and Dunedin, but more temperate and mild at Auckland and New Plymouth on the west coast of the northern island.

The diseases prevalent in summer are diarrhœa and dysentery, and a number of deaths occur from consumption throughout the year; and there is said to be a tendency among the colonists to rheumatic troubles.

It appears, then, that no locality in Australia, Tasmania, or New Zealand, is suited for advanced cases of consumption; that where a desire existed to avert a threat of consumption, not actually developed, Tasmania, Sydney, or Western Australia might be chosen, if the higher altitudes of the Swiss Alps or the Colorado Mountains were not open to the person; and that these islands of the southern hemisphere offer bright and genial climates to all in good health, and a pleasant and beneficial resort to those suffering from the enervating effects of tropical heat such as that of India.

PART III.

MEDICINES AND THE PURPOSES FOR WHICH THEY ARE EMPLOYED.

INTRODUCTION.

The Rational Employment of Medicines:
The Meaning of Therapeutics, of Rational and Empirical Treatment.
Modes of Administering Medicines:
Administration of Medicines by the Mouth, and by Injection into the Bowel;
Hypodermic Injection—Injection under the Skin;
Administration by Rubbing on the Skin, by Inhalation, by Baths, &c.
The Dose of Medicines:
Table of Doses suited to Different Ages.

The Rational Employment of Medicines.

The "practice of medicine," that phrase being used to mean the business or work of the medical practitioner, is inseparably associated, in the public mind, with the prescribing of drugs. The man who suffers from some discomfort, some disorder or other, a pain in his stomach, a pain in his head, a bad taste in his mouth, a want of appetite for his usual food, a cough, sleeplessness, or other ailment, presents himself before his doctor. What he expects to follow is something like this. He will inform the doctor that he suffers from indigestion, or that he "wants something for a bad cough," or that he is troubled with headache, or whatever his complaint may be; thereupon the doctor may go through a few formalities, such as looking at his tongue, feeling his pulse, and so on; then he will write a prescription, which the patient takes to a druggist; the druggist prepares, as ordered, a mixture—"a bottle"—or a pill, or a powder, which when the patient has taken, his stomach-ache or headache, or cough, or sleeplessness, ought to depart. These are the lines of the orthodox routine, "without which none is genuine," according to the generally held public view of the doctor's duties. There are, of course, variations in detail. One patient will interrupt the doctor, when he is about to ask a few questions, with such a remark as, "Oh! I know quite well what is wrong; it is just indigestion; can you not give me something for it?" Another is not sufficiently impressed with his adviser's care and attention unless the adviser puts him figuratively into the witness-box, examines and cross-examines him, produces a big book and duly enters the answers to the questions, and writes up a long statement of "his case." In the end, however, whatever be the course chosen, the bottle, pill, or powder must be ordered. That this is the view prevailing, more or less, among all classes, among the learned as among those unlearned, is daily illustrated in the work of every practitioner of medicine. "What is good for a cough, doctor?" "I wish you would give me something to cure my headache," and so on, are among the everyday requests, addressed to the medical man. There is some drug or other which is suitable for the removal of every ailment, is the general belief which prevails. If one doctor does not hit on the appropriate remedy another may, and so one doctor is tried after another, which is to say, one drug is tried after another, or one combination of drugs after another. If the cure is not obtained it is because the appropriate remedy has not been ordered or has not yet been discovered. One sufferer from indigestion has had some remedy prescribed which has proved effectual, and he hands round the prescription among any of his friends who suffer from a like complaint, with the perfect assurance that it will relieve them as it relieved him. The progress of medicine will thus consist in the discovery of new drugs, or in the application of drugs already known in new ways or for diseases they have not hitherto been supposed to be useful in. Now this is altogether a very imperfect view of the medical art, and an exaggerated notion of the value of medicines. The man who asks what is good for a cough, and expects an answer as promptly as he would to the question, what will remove ink-stains from linen? or what will cure a smoky chimney? overlooks the fact that his body is a complicated organism, a combina-

tion of numerous associated organs, working for a common end, the sphere of action of a multitude of intricate processes, and cannot be handled as a lifeless thing, a part of which can be acted on without the whole being more or less affected. He overlooks the fact that the healthy action of his body is the result of a multitude of conditions, connected with the food he eats, the water he drinks, the air he breathes, the clothing he wears, the house he dwells in, the daily work he performs, and the circumstances of his social life, and that the unhealthy action of his body may be connected with any, or many, or all, of these conditions. The man who treats disease on rational principles does not seek simply to determine what is the proper name to attach to a complaint from which his patient suffers, in order to say what drug is suitable for it. He seeks rather to obtain a knowledge of the conditions under which his patient lives, of the manner in which the various organs of his body are performing their work, whether their performance is of a healthy kind; if not, wherein they are defective, or wherein they depart from the healthy standard. When he has determined these things to his satisfaction, he asks himself how this departure has arisen, what is keeping it up, what is encouraging it or preventing a restoration to the natural state of things. When the information thus obtained is before him, he probably has the means of deciding how the unhealthy action may be prevented, how a return to the healthy action may be promoted, what procedure is likely to encourage a restoration to health. It may be that to achieve this desired end drugs are not necessary, may, perhaps, be hurtful rather than the reverse. It is only too likely that the reason of the disturbance of the healthy activity of the body will be found in some of the conditions of the patient's life, in some error of eating or drinking, in some unhealthy state of the air of house or workshop, in some circumstance connected with the patient's trade or occupation. If the reason of the disturbance is found and removed, then the natural tendency of the body to conduct its operations in a particular way—the way for which it was designed, the healthy way—may be sufficient to restore health, and the cure is thus effected without drugs. It may be possible to quicken the process of restoration by administering some substance which is known to have some particular effect upon a certain organ of the body, by whose effect the disordered action may be lessened and the tendency to return to the natural action encouraged. In which case the medicine is ordered; but it is not the cure; it is only one of the helps to a cure. It is given only to reinforce the other means set in operation to effect a return to health.

The treatment of disease, then, is not solely, nor mainly, the administration of medicines. The administration of medicines is only one of the means of treating disease, one of many means, though undoubtedly, when wisely directed, a very valuable means. The tendency to return to natural healthy action—the *vis medicatrix naturæ*, the healing influence of nature—or, from another point of view, the natural resistance of the body to disease, is what the wise physician mainly relies on really to cure the disease. This influence he encourages, excites, stimulates; difficulties in its way he tries to modify or remove; he "stands by," to use a nautical phrase, to modify or avert any interference with its full play which he sees likely to arise, or finds actually existing. For this purpose he directs the kind of food and drink to be taken, the most suitable climate, and for this purpose he employs what medicine he deems advisable. So it is that the use of medicines is only one, and not the chief, means adopted in the treatment of disease. The word **therapeutics**, therefore, which is commonly used in a narrow sense to imply the use of drugs in the treatment of disease, has a far broader meaning. It is derived from the Greek *therapeuo*, I heal, or I treat, and it really includes every means employed to restore a healthy state to the body.

These considerations will help us to understand the kind of knowledge that is needful for the successful employment of medicines. The physician must first know what the healthy action of the body really is. He must learn what the healthy action of the heart, lungs, liver, bowels, nervous system, all the organs of the body, is. He must be able to appreciate what changes are produced in those healthy activities by various states of disease; he must be able to search for, and detect, a departure from the natural state, and understand its nature and its effects. He is not yet ready, however, to treat disease. It is not enough to know how the body works, so to speak, when it is in health, nor yet sufficient when, to that knowledge, is added an ability to discover when it is working badly and why. For he does not yet know how its healthy action is affected by various conditions, nor how he can bring influences to bear on its disordered action. To the knowledge of how the body works when in health, must be added an understanding of the various means

by which that healthy action can be influenced. For example, a man may know a great deal about the action of the heart, how often it contracts during one minute, with what force it contracts, what the order of its movements is, what are their effects, and so on, and yet be unable to tell how the action of the heart may be quickened or slowed, weakened or strengthened. Or again, one may know a good deal about the liver, what is the build, size, shape, position of the organ, about its work in the body, about the bile which it produces, what its chemical and other properties are, and so on, and yet have not the smallest knowledge of any means by which the liver may be stimulated to increased action, to produce more bile, or how its action may be diminished so that it produces less, and so on. If one is not aware how the various activities of the body may be influenced by conditions either within or without the body in a state of health, how can one understand how to influence the action of the various organs when there is some state of disease? If one cannot tell how the action of the healthy heart may be strengthened, how is one to know what to do to strengthen a heart so weakened by disease, as to have become almost unfit for its work? If one is not aware what will slow the movements of the healthily beating heart, how is one to know what to do to diminish the speed of action of a heart beating with a rapidity which threatens rapid exhaustion of all power to beat at all? If one is not aware how to stimulate the flow of bile from the liver in a state of health, how is one to know what to do to "poke up" a liver which has become slow in the performance of its share in the work of the body. The training of the physician, then, implies the opportunity of becoming acquainted with the effects upon the body, and upon its various organs when in a state of health, of various conditions and substances, and an acquaintance, so far as that can be gained, with the effects of similar conditions and substances on the manifold disordered states to which the body is subject. The knowledge of the influences that may be brought to bear upon the *healthy* body it is the business of the science of physiology to acquire, and the effect of any substance upon the body in a state of health is said to be its physiological action. The study of the effects upon the body in a state of disease belongs to the science of therapeutics, the science of treatment.

Well, then, the points we have been trying to emphasize are: *first*, that the treatment of disease is not entirely or mainly an affair of drugs—the administration of medicines is, indeed, only a small part of it; and, *second*, that the administration of medicines is not, or ought not to be, an affair of happy chance, or hap-hazard, or rule of thumb, but ought to be determined by (1) a knowledge of the healthy action of the body, (2) a knowledge of the effects of disease in altering healthy action, (3) a knowledge of the influences that can be brought to bear upon the body in health and their mode of operation, and (4) a knowledge of the means by which the body and its various organs can be influenced in a state of disease. What, then, is meant by the rational employment of drugs will be understood. Let us take an example:—A person is attacked with inflammation of the lungs. The physician knows how the lungs should act in a state of health, this physiology has taught him; his study of pathology—the science of disease—has revealed to him how that action is interfered with by various states of disease, and how the particular kind of disease is determined. His examination of the person has shown him the condition of the affected lung, and he has found that a large part of one lung, let us say, is filled up with the products of inflammation so that it can no longer do its share of the work of introducing oxygen to the blood and removing carbonic acid gas from it. This condition of the lung is such that the blood flows through it with great difficulty, that the heart, which drives the blood through it, has enormously increased labour thrown upon it to carry on the circulation, and, besides, the state of fever, the interference with digestion, caused by the disease, and so on, are producing exhausting effects upon the whole body, and on the heart as part of it. For all these reasons the heart has become enfeebled, is showing signs of tiring, so to speak, is weak and irregular in its action, and the risk exists that the patient will die, not directly because of the inflamed lung, but because the heart will fail altogether, because of the undue strain thrown upon it. In a few days the physician expects that the inflammation will abate, and the lung will begin to clear up, and the strain upon the heart will lessen. Meanwhile, however, it is questionable if the heart can hold out till relief begins. So the physician asks himself what can be done to steady the action of the heart and strengthen its contraction, what can he do to aid it to tide over its time of difficulty. The study of the action of medicines has taught him that a drug, digitalis, diminishes the frequency of the heart's beat and increases its force, and his

knowledge of the diseased state indicates that this is the effect that will prove beneficial. So he orders digitalis. He does not simply order a mixture, containing digitalis, and cause a teaspoonful, or any other quantity to be given, mechanically, every three hours, or four times a day, or whatever it be, but he watches its effects. He finds the heart is a little improved, but not very markedly, so he increases the dose; and after a little time longer, it may be, he increases it still more, till he reaches a dose when the effects he desires are obtained, the heart now beats steadily and firmly. Meanwhile his treatment of the inflammation of the lung goes on. In a few days the lung begins to clear up, the difficulty begins to decrease; he begins now slowly to diminish the digitalis, and at length finding the heart no longer fails, is now no longer oppressed with labour, he can safely stop the digitalis altogether, his timely aid having been sufficient, while the time of undue labour lasted.

This is an illustration of a drug rationally employed. The effect to be produced is understood, a drug which can produce this effect is known, and so the drug is given till the desired result is achieved. Let us take another example of a different kind. A person has, by accident, swallowed a poisonous dose of corrosive sublimate—a salt of mercury. If the drug passes into the circulation and is, by the blood, distributed throughout the body in sufficient quantity, its effects will kill him. Obviously the rational treatment is to get the poison out of the stomach before it has had time to be absorbed in sufficient quantity. So the doctor applies the stomach-pump, empties and washes out the stomach. Perhaps a stomach-pump is not at hand, so he tries to make the stomach empty itself; he excites vomiting by tickling the throat with a feather, or putting the finger down. Some of the poison may still be left in the stomach, adhering to its walls, can he give anything which will prevent the poison passing into the circulation? It can only pass into the blood if it is in a state of solution; if the corrosive sublimate is not dissolved, it cannot gain entrance to the blood, and so will do no harm. Now corrosive sublimate forms with albumin an insoluble substance, albuminate of mercury. White of egg consists chiefly of albumin, so the whites of several eggs are rapidly beaten up in water and given to the person to drink, and thus an antidote to the poison is administered.

Now it is not always possible to make use of drugs because of such well-defined reasons as these. Many medicines are used for particular diseases in which their effects have been proved by experience to be useful, and yet the reason of their usefulness, the exact means by which they are beneficial, are not known. Experience only has taught that they are useful, in certain cases, but the reason of their usefulness remains to be discovered. Whether they relieve, or whether they fail to relieve, no scientific reason is yet forthcoming. In such cases the medicine is said to be given **empirically**, and the treatment is said to be empirical treatment. It is undoubtedly the case that a very large number of the remedies regularly employed, including some of the most useful of the remedies in the hands of the physician, are used because experience has shown their value, although the reason of their usefulness is not at all or not well understood. But physicians do not refuse to order medicines, which have been shown without doubt to be appropriate in certain cases, because they do not yet know how they bring about the desired end. It is, however, the object of the modern science of medicine, bringing chemistry and physiology and pathology to its aid, gradually to reveal more and more clearly how these remedies act, and so to increase the number of the drugs which are employed because their mode of action is well understood, and to diminish the number of drugs which are recommended merely because of the facts of experience. This result the science of medicine is gradually achieving; and year by year drugs are being taken out of the class of those used empirically and added to the number of those used rationally. A most notable illustration of this is found in the well-known medicine quinine. Long ago quinine and Peruvian or cinchona bark, from which quinine is derived, were known to be invaluable medicines in the treatment of fevers, and specially of those—such as ague—dependent upon malaria. The cure of ague was regarded as almost a certainty by the administration of quinine long ago, and as late as 1857, Sir Thomas Watson said of it: "I may observe, however, that this is a remedy to which we could never have been led by any process of reasoning. It is a matter of pure empiricism. We know nothing of the seat or of the essential nature of the disease (ague); we are equally in the dark as to the *modus operandi* of the quina in curing it; yet our knowledge of ague, upon the whole, estimated in reference to its precision and practical bearing, is more satisfactory than of many other complaints, with the seat and nature of which we are much better acquainted. The group of symptoms is so distinct, that we

have no trouble or doubt as to the diagnosis; and experience has taught us a remedy which is all but infallible." This might have been said of quinine up to a much later date. Now, however, physiological investigations have revealed much of the way in which quinine acts in controlling certain kinds of fever, and concerning it we may now be said to have passed beyond the mere stage of experience. How salicine, derived from willow bark, acts so marvellously in rheumatism, diminishing the fever, relieving the pain, and removing the swelling, it is impossible to say, yet experience warrants one in almost asserting that in a few hours acute rheumatic fever will yield to its use.

While this is so, still the object of all those who work in the various departments of medical science is to reduce it more and more to the limits of an exact science, to discover the real nature and ultimate causes of disease, to ascertain the actions of drugs in health and in disease, so that those who practise the art of medicine shall always have well-defined reasons for the employment of all the means of meeting disease, and shall have more and more certainty of successfully combating and overcoming it.

Modes of Administering Medicines.

Medicines produce both what is called a local and a remote effect. That is, they act directly upon the part with which they come into contact, and they also act upon parts distant, usually by passing into the blood and being carried thence to other parts of the body. Sometimes it is only the local effect one wishes to produce, as when carbolic acid or other similar substance is applied to an ulcer to convert it into a healthy sore, sometimes one wishes to get the medicine into the blood only so that it may be carried to the distant organ. The usual way of getting the medicine into the system is by giving it by the mouth. It is then swallowed, and passes into the stomach. From the stomach it is absorbed by the blood-vessels, and thus carried through the whole body in the blood stream. Reaching all parts of the body, it may influence all the tissues and organs, but commonly one or more organ is affected more than others, and a special effect is thus produced. Often there are objections to giving it by the mouth. One may desire to avoid its local action on the walls of the stomach, the irritability of the stomach may be such that the substance is vomited speedily after it is swallowed, and another method of introduction is desirable. In such a case the medicine may be mixed with a solution of some non-irritating material like starch and injected into the bowel, from which it is absorbed and passes into the blood. Or the drug may be dissolved in a few drops of water and injected under the skin. This is called *hypodermic injection* (Greek, *hupo*, under, and *derma*, the skin). The instrument used for the purpose is a hypodermic syringe. It is a small, usually glass, syringe, capable of holding 20 or 30 drops, the barrel of the syringe being marked so that the number of drops injected may be easily known. To the nozzle of the syringe is screwed a long slender needle, with a fine canal running through it, and ending in a sharp point. The solution being sucked up into the syringe, the needle is screwed on; slight pressure on the piston drives the solution along the needle till its canal is filled, then the skin is picked up between finger and thumb and the needle thrust through it. The piston is then pressed till the requisite quantity is injected. On withdrawing the needle one presses over the puncture to prevent escape and gently rubs the skin over the seat of injection to cause the fluid to be diffused through the tissue under the skin, and so ensure it being rapidly picked up by the vessels—blood-vessels and lymphatics. This is one of the quickest ways of procuring the action of a drug, it so rapidly gains entrance to the current of blood. A drug may be rubbed on to the skin, and it will produce an effect not only on the part to which it is applied but also on the system in general, because, if well rubbed in, it gets into the vessels. Occasionally the top skin, or scarf skin, is removed by a blister, and a drug, in powder, sprinkled on the raw surface. Some is absorbed and produces remote effects. Then drugs are sometimes caused to enter the body by inhalation—the drug is disseminated through the atmosphere in vapour, and the vapour being breathed, and the drug getting into the lungs, is absorbed by the vessels of the moist delicate mucous membrane. The drug may be converted into vapour and the naked body exposed to its influence, the arrangement being that described for the vapour bath (p. 738). In such a case it is absorbed by the skin. Medicated bath may be given as a means of introducing the medicine into the body. Finally, the speediest method of all would be to inject the drug directly into the blood by a vein, *intravenous injection*, but this method is seldom employed. The speediest method commonly employed is that by hypodermic injection. A small quantity of the drug, thus given, will act as effectually as a larger dose by the mouth,

for it enters the circulation more quickly, and there is a larger quantity circulating at one time. When the drug is given by the mouth, its absorption from the stomach is so much slower, comparatively speaking, that some of it may be already expelled from the body by way of the kidneys, skin, and lungs, before the last of it is absorbed. Then the juices of the stomach, &c., may so act upon the medicine as greatly to change its nature and prevent its full action being produced, an effect avoided by injection under the skin. Thus everything absorbed from the stomach passes through the liver, and the medicine may be much altered in its course. Therefore, a much smaller dose is given by hypodermic injection than would be given by the mouth or bowel.

Dose of Medicines.—The dose of medicines should be regulated by the body weight, for the same dose administered to a small and a large person will be distributed through a smaller quantity of blood in the small person, and thus each organ of the body will receive a larger share than the corresponding organs in the person of greater size. Women, therefore, require a smaller dose than men, and children than grown persons. Age is regarded as the convenient guide in regulating the dose. One rule for fixing the dose for a certain age is to take the age in years of the person, add to it 12, and with the sum divide the age in years, the result expresses the fraction of the full dose to be given. Thus a child's age is 4 years, 4 added to 12 makes 16. Divide the age in years by 16—$\frac{4}{16}$th is the fraction of the full dose for a child of 4 years. $\frac{4}{16} = \frac{1}{4}$, and if the full dose is 4 grains, the child should get 1 grain. The following table may be taken as a guide:—

A child under 1 year	will require only	$\frac{1}{12}$	part of the full dose.
,, 2 years	,,	$\frac{1}{8}$	,,
,, 3 ,,	,,	$\frac{1}{6}$	,,
,, 4 ,,	,,	$\frac{1}{4}$	,,
,, 7 ,,	,,	$\frac{1}{3}$	,,
,, 14 ,,	,,	$\frac{1}{2}$	,,
A young person under 20	,,	$\frac{2}{3}$	,,

A person above 21 receives the full dose.
After 65 years of age the dose is diminished.

It may further be noted that young persons are much more susceptible to the action of certain drugs than are old persons. For instance, children are peculiarly strongly affected by opium, or any of its preparations, such as laudanum, and to them it cannot, therefore, be given too carefully. On the other hand children are *less* affected by preparations of mercury than are adults; and there are instances on record of calomel, a preparation of mercury, having most serious effects on an adult, when given in a dose which almost the youngest child could stand. Another drug to which children are less susceptible than adults is belladonna.

Besides all this, custom, temperament, the influence of climate, and personal peculiarities affect the question. Many people are peculiarly affected by certain drugs, even as many are peculiarly affected by certain foods, while others are hardly influenced at all except with large doses. Opium and mercury are notable illustrations; the smallest doses of these being scarcely tolerated at all by many persons.

We shall now proceed to consider some of the chief remedies and means of treatment in their effects upon the body, and their use in disease, considering them as far as possible according to the organs of the body they chiefly influence.

SECTION I.—MEDICINES WHICH ACT UPON THE BLOOD AND WHICH AFFECT THE NUTRITION OF THE WHOLE BODY.

Medicines which Act upon the Blood.

Blood Tonics:

Iron—Its Preparations and their Doses—Tincture of Steel, Iodide of Iron, Chemical Food, Blaud's Pill, &c.—Its Action and Uses in various Diseases.

Medicines which Increase or Diminish the Alkalinity of the Blood:

Potash—Its Preparations and their Doses—Carbonate and Citrate of Potash, &c.—The Use of Potash in Rheumatism, Gout, and Gravel;

Soda—Bicarbonate of Soda and Rochelle Salts;

Lithia—Its Use in Gout.

Remedies which Cool the Blood—Antipyretics:

Quinine and Peruvian Bark—The Varieties of Cinchona Barks—The Preparations of Bark —The Preparations of Quinine—The Use of Quinine as a Tonic, for Fever and Ague, and as a Disinfectant—Warburg's Tincture;

Salicine—Its Use in Rheumatism;

Salicylic Acid and Salicylate of Soda;

Antipyrin—Its Employment for Fever, and its Use for Nervous Headache;

Thallin, *Antifebrin*, and *Kairin*.

Medicines which Act on Tissue Change.

Alteratives:

Arsenic—Its Chief Preparations—Precautions in its Use—Arsenical Poisoning—Its Use in Skin Diseases;

Mercury—Its Compounds, Action, and Value—Mercurial Poisoning;

Iodine and Its Use in Scrofula and Gland Diseases;

Phosphorus and Its Preparations;

Sulphur—Its Use in Liver Disorders and Skin Affections—Sulphuretted Hydrogen Treatment in Consumption;

Sarsaparilla;

Colchicum—Its Employment in Gout;

Guaiacum—How applied for Sore Throat and Rheumatism;

Mezereum Bark.

In the first part of this work we have considered the characters and composition of the blood (see p. 212); we have considered also the part which the blood plays in the body. We have seen that the whole body, and every part of the body, are dependent upon the blood for the material for their healthy growth and for the material for their healthy activity. The blood is the nourishing fluid of the body, containing within itself all the materials for the building up of every tissue, muscle, nerve, bone, skin, and so on, for the production of every juice required in the body, the digestive juices for example, and for the repair of all tear and wear, continually going on. It is distributed to every organ, and brought within reach of every tissue; and the tissues possess the power of selecting from it the constituents they require for their continued healthy existence. We have considered also how the blood, thus continually being drained of its nourishing materials, is as continually restored to a healthy standard and maintained in a condition fit for the purpose it has to serve. The means for this purpose are mainly food and drink introduced by the mouth and prepared for entering the blood by the digestive organs, and oxygen gas, which the blood obtains through the instrumentality of the lungs. Our earlier studies have also shown us that the blood is, besides, a means of removing from tissues and organs the waste products, due to the activity of the organs and tissues, and how the liver, the bowels, the lungs, the kidneys and the skin, act in ridding the blood of these waste substances and thus maintaining its standard of purity. Through the blood, then, the condition of the whole body may be influenced. If it is impoverished or impure, the organs and tissues will not derive the needed nourishment; or some organs may obtain a fair supply and others may feel the impoverishment more; or along with the needed material for growth and work may also be obtained, because of the impurity, something hurtful to the healthy action of the organ or tissue. If some additional substance be taken into the stomach, which is

able to pass into the blood, it will be carried to all parts of the body. If it is an active substance it may affect more or less every organ and tissue of the body, or it may be of a character fitted to act upon one organ more than another, and may profoundly affect the whole body by its universal action or by specially influencing one or two organs in partcular.

Thus, then, it is plain there are two great ways of influencing the nutrition of the whole body in general: (1) either by acting directly on the blood, or (2) by introducing something into the blood which shall be conveyed by it to all parts of the body and shall modify the action of the tissues when it arrives there. To the first class of remedies belong **blood tonics**, of which the conspicuous example is iron; while the second class is called **alteratives**, that is, they alter or modify the changes going on in the tissues, though how they do so is not well understood, and to that class arsenic, mercury, iodine, and others to be named later, belong.

MEDICINES WHICH ACT ON THE BLOOD.

The blood (see p. 216) consists of minute bodies, corpuscles, red and white, floating in a fluid, liquor sanguinis or plasma. Now the red corpuscles are formed of an albuminous body, hæmoglobin, which contains iron, and they also contain salts of potash and phosphorus, and fat. These red corpuscles give the colour to the blood, and if they are deficient in number, the paleness of the skin is marked, and a condition of bloodlessness, or anæmia, is the result. By supplying to the blood iron, fat, potash salts, the constituents of the corpuscles, much can be done to remedy this condition, supposing, of course, that at the same time appropriate food is given, and fresh air and sunlight and exercise are not forgotten. Then, again, the liquid of the blood contains albumin, soda salts, fat, &c., and by a due supply of these substances an improved condition may be brought about. Because of the soda and potash salts of the liquid and red corpuscles of the blood the blood is not acid but alkaline, and in certain diseases, notably rheumatism and gout, the alkalinity is diminished. By administering soda or potash salts it can be increased, and this is actually part of the treatment in the diseases named. Again, scurvy, a disease in which the nutrition of the whole body is profoundly impaired, is believed to be due to the absence from the blood, or deficiency, of some of its constituents, perhaps potash salts, to be remedied by giving fresh meats and vegetables which contain the salts, or by the use of lime-juice.

Thus we see how the condition of the blood can be influenced by the administration of substances which are needed for its formation and which otherwise act upon it directly, and how in consequence the nutrition of the whole body may be improved.

Then, again, the red corpuscles, because of the hæmoglobin of which they are mainly composed, act as the distributors of oxygen gas to the tissues, without which their activity cannot be carried on. The hæmoglobin forms a loose chemical compound with oxygen, and when the blood obtains the oxygen in the lungs, it is forthwith carried to the tissues and delivered up to them, so to speak. If the corpuscles are deficient, then oxygen in sufficient amount cannot readily be carried to the tissues. They cannot carry on their processes with ordinary activity, and all the energies of the body become, in consequence, diminished; the patient is weak, languid, dull, sleepy; and the heart is greatly quickened and the breathing hurried with the least exertion, perhaps in the attempt to make up for the defective oxygen-carrying capacity of the blood by increasing the rate of its distribution through the body, that is to say, by making the corpuscles travel all the oftener between the lungs and the tissues. By the administration of iron with appropriate food, &c., the multiplication of red blood corpuscles is encouraged, and relief in time obtained.

Now there are drugs which interfere with the yielding up of oxygen to the tissues by the red corpuscles. The corpuscles duly bring their load of oxygen, but are prevented handing it over, so to speak. This is an effect which is produced by alcohol, and is also produced by quinine. It is an effect which one would not seek to produce in health, but is often exceedingly valuable in disease. For instance, in fever the heat of the body is greatly increased, owing, in certain fevers at any rate, to too great *production* of heat in the body. We know that heat in the body is produced in the same way as heat outside of the body is produced (see p. 527), by a union of certain substances, carbon and hydrogen, with oxygen. The substances that unite with the oxygen are in the tissues, and the oxygen, as we have said, is brought to them by the blood. If the oxygen is so firmly united to the corpuscles that it is given off from them with difficulty, the chemical combination will be diminished and less heat will be pro-

duced. This is the effect of quinine, and thus in cases of fever it diminishes the heat of the body by lessening the production of heat, by preventing the corpuscles giving up their oxygen so quickly as they would otherwise do.

The general action of remedies on the blood having thus been briefly indicated, we shall now shortly note the chief points of importance connected with the drugs.

Blood Tonics.

Blood Tonics are remedies which improve the quality of the blood by supplying materials in which it is deficient. The chief of them are also called **hæmatinics,** because they increase the quantity of colouring matter in the blood.

Iron in some form is the chief blood tonic. The chief preparations of iron in common use and their doses are as follows:—

	DOSE.
Reduced Iron	2 to 6 grains.
Saccharated Carbonate of Iron	5 to 20 ,,
Sulphate of Iron	1 ,, 5 ,,
Dried Sulphate of Iron	½ ,, 3 ,,
Phosphate of Iron	5 ,, 10 ,,
Syrup of Phosphate of Iron	60 drops.
Tincture of Steel (Tincture of Perchloride of Iron—Steel Drops)	10 to 40 drops.
Dialysed Iron	10 ,, 30 ,,
Iron Wine	1 to 4 tea-spoonfuls.
Tartrate of Iron (Potassic Tartrate of Iron)	5 to 20 grains.
Citrate of Iron and Ammonia	5 ,, 10 ,,
Citrate of Iron and Quinine	5 ,, 20 ,,
Iodide of Iron	1 ,, 5 ,,
Syrup of Iodide of Iron	20 to 60 drops.
Arseniate of Iron	$\frac{1}{16}$ to ⅛ grain.

Griffith's Mixture (compound mixture of iron) is a favourite iron mixture, containing sulphate of iron (25 grains), carbonate of potash (30 grains), powdered myrrh (30 grains), spirit of nutmeg (½ oz.), sugar (60 grains), and rose-water (9 fluid ounces). Dose—1 to 2 fluid ounces.

The myrrh, spirit of nutmeg, and carbonate of potash are rubbed up together in a mortar, then the rose-water is added and well mixed, then the sugar, and lastly the sulphate of iron. It should be kept in a stoppered glass vessel.

Parrish's Syrup or Chemical Food is another favourite remedy, containing phosphate of iron, with the phosphates of lime, potash, and soda, dissolved in dilute phosphoric acid and sugar added. Dose—1 tea-spoonful.

Easton's Syrup is a syrup containing phosphate of iron with the phosphates of quinine and strychnine. Dose—½ to 1 tea-spoonful.

Syrup of the Hypophosphites contains iron, lime, potash, soda, &c., as well as other ingredients like quinine and strychnine. Dose—½ to 1 tea-spoonful.

Blaud's Pill contains sulphate of iron and carbonate of potash. In the stomach carbonate of iron is formed. It is a very good form for the administration of iron.

Action and Uses of Iron.—The preparations of iron have an effect upon the tissues with which they come into contact before they enter the blood. Thus the astringency of most of the preparations is perceived by the action on the mouth. They discolour the teeth, and thus when not given in the form of pill, but as a liquid, they should be taken through a glass-tube, a straw even would suit the purpose, and the mouth and teeth should be well washed afterwards. They exert a constringing effect upon the lining membrane of the throat, gullet, stomach, and bowels. They cause blood to contract and form a clot with albuminous bodies, such as blood. Now this purely local action is often useful, and they are, therefore, used to diminish discharge from organs, to arrest bleeding, and for similar purposes. Thus, besides being given by the mouth to produce such local effects on the mouth or throat, stomach or bowels, they are employed as injections, in cases of bleeding from the nose, bleeding from gums, from leech-bites, &c. In some of the preparations these effects are specially marked, the tincture of steel and sulphate of iron, for example. It is the same action which makes iron preparations valuable in cases of relaxed bowel, diarrhœa, and so on. The astringency, however, causes iron to be badly borne by many persons, persons with irritable stomach for example, and is disadvantageous in cases where there is no looseness of bowels, from the tendency to cause constipation. It is, therefore, common to combine with the preparation of iron some substance which will have an opening effect. Thus the iron-and-aloes pill acts upon the lower bowel, securing a movement, while the benefits of the action of iron are also obtained. It must be noticed also, that iron preparations colour the motions black, owing to the formation in the bowel of the black sulphide of iron.

In cases where the local action is not specially desired, one seeks to make use of those forms of the remedy which have the least constringing action, since this effect is apt to irritate the stomach and bowels. If the person has a red, raw-looking tongue, this is held to indicate an irritable condition of stomach, when iron would not be given, or only in the mildest form in

small doses. When the tongue is pale, flabby, and shows the marks of the teeth on the edge, iron is suitable. The least astringent forms are the reduced iron and dialysed iron specially, the saccharated carbonate of iron, the phosphate, tartrate, and citrates of iron, and the hypophosphite.

The direct action of iron on the red corpuscles is the peculiarly valuable effect for which iron is most usually administered, its effect upon the organs and tissues being practically none, except through the improved quality of the blood which it produces. It is thus the most useful drug in bloodlessness (anæmia), in all conditions of impaired nutrition, in cases of wasting due to loss of blood or chronic discharges, in the condition of weakness following fevers, in scrofula, in malarial poisoning, in blood poisoning, in diphtheria, erysipelas, &c. For the two last-named diseases it is given in large doses, the tincture of steel being very useful in 10-drop doses given in water five times a day, or the dialysed iron. The carbonate of iron, Griffith's mixture, Blaud's pill, and the syrups of the phosphates or hypophosphites are also the most serviceable. In chronic kidney disease it is also used. In nervous diseases, and in the flushings experienced at the change of life, any of such preparations is most valuable. In nervous cases the combinations with strychnine, such as in the compound syrup of hypophosphites or Easton's syrup, are those to be employed.

The citrates of iron are the mildest preparations, and may be given when it is doubtful if other forms will be well borne.

In cases of deficiency of the menstrual flow the carbonate of iron and Blaud's pill are commonly employed.

The combination of iron with iodine, and specially the syrup iodide of iron, is one of the most valuable remedies for scrofula and affections of glands; and there is scarcely a better remedy than this for the pale, flabby, unhealthy children of towns, given to the extent of 15 drops or thereby, dropped into a teaspoonful of cod-liver oil, three times daily. Nervous diseases of children derive great benefit in many cases from such treatment. The syrup of the phosphate of iron is suitable for rickety children.

The compound of iron and arsenic is useful for skin affections in pale persons, and for other anæmic conditions, but it ought scarcely to be used without proper advice.

Iron is an antidote, in one of its forms, to poisoning by arsenic. The form used is the hydrated oxide, when freshly prepared, by adding a solution of soda or ammonia to the tincture of perchloride of iron in water, or to a solution of the sulphate of iron. It forms with the arsenic an insoluble compound. A brisk purgative should afterwards be given.

Medicines which Increase or Diminish the Alkalinity of the Blood.

The chief remedies which increase the alkaline character of the blood are potash, soda, magnesia, lime, and lithia.

Potash.—The chief preparations of potash are as follows:—

	DOSE.
Carbonate of Potash	10 to 30 grains.
Bicarbonate of Potash	10 ,, 40 ,,
Solution of Potash (Liquor Potassæ)	15 ,, 60 drops in a wine-glassful of water.
Iodide of Potassium (see p. 825)	2 to 10 grains.
Bromide of Potassium (See under Drugs which Act on the Nervous System.)	5 ,, 30 ,,
Citrate of Potash	20 ,, 60 ,,
Acetate of Potash	10 ,, 60 ,,
Nitrate of Potash	10 ,, 30 ,,
Chlorate of Potash	10 ,, 30 ,,
Acid Tartrate of Potash (Cream of Tartar)	60 grains and upwards.

Actions and Uses of Potash.—This remedy produces very different effects according to the form in which it is used, and acts on many organs, according to the dose given. Thus caustic potash, usually in the form of white pencils, is employed for its destructive action on the tissues to destroy unhealthy ulcers, remove tumours, &c. Then potash is employed for its chemical antagonism to acid, being given to neutralize acidity of the stomach as soda is given. For this purpose the bicarbonate is the best. The solution of caustic potash (liquor potassæ) is also employed, but it requires to be largely diluted; it cannot be taken to any extent because of its corrosive action; and is not to be recommended. Then the action of the bromide and iodide of potassium depends chiefly on the bromine and iodine in combination, and these substances are discussed elsewhere. The carbonate, bicarbonate, tartrate and acid tartrate act in large doses on the bowels, producing copious watery stools. This action is referred to in considering the drugs acting on the bowels. Again, the citrate, acetate, and nitrate act specially on the kidneys and are, therefore, considered in the section devoted to drugs which act on the kidneys.

It is the action of potash on the blood that

is to be mainly noted here. It readily gains entrance to the blood, increasing its alkaline reaction. Then the red corpuscles contain potash salts, and in disordered conditions of blood the use of potash, *in combination with iron*, greatly improves the quality of the blood by increasing the number of red corpuscles. For this purpose the best form is Blaud's pill (see p. 817) or the compound iron mixture (see p. 817). Potash is used by itself in diseases supposed to be due to an excessive amount of acid in the blood, such as rheumatism and gout. For this purpose the bicarbonate, the citrates, acetates, and tartrates are employed. Nitrate of potash—saltpetre—is an old remedy, in high repute, for rheumatism. These drugs, after passing into the blood, where they are mostly converted into carbonates, are excreted by the urine, the acidity of which they diminish, or, if in sufficient quantity, altogether remove. They are, therefore, valuable for relieving the scalding due to the irritating effect of excessively acid urine, and to prevent the formation of stone by the deposit of uric acid. Then in being excreted by the kidneys they so act upon them as to produce a greatly increased flow of urine. Owing to the increased separation of water from the blood, dropsies of various kinds are diminished, because the fluid of the dropsy is picked up to restore to the blood its normal quantity of water. The citrate of potash is useful as a preventive of scurvy.

The chlorate of potash is principally used for its local action on ulcers, thrush, and other similar affections of the mouth, throat, stomach, &c. It very speedily exerts a cleansing and healing action on the lining membrane of the mouth and throat affected by patches of ulceration, &c. It is, therefore, used in these conditions and in cases of relaxed throat, in diphtheria, &c. A very convenient form of administration is the pellets, containing 5 grains each, now to be had of nearly every druggist, and the chlorate of potash pastilles. It is said, also, when it gains entrance to the blood, to give up some of the oxygen, in which it is rich, and thus act upon the blood after the manner of a disinfectant in cases of diphtheria, blood-poisoning, &c.

Soda.—The chief preparations of soda are:

	DOSE.
Carbonate of Soda	5 to 30 grains.
Bicarbonate of Soda	10 ,, 60 ,,
Tartrate of Soda and Potash (Rochelle Salts)	¼ ,, ½ ounce.
Phosphate of Soda	¼ ,, 1 ,,
Borax (Biborate of Soda)	5 ,, 40 grains.
Hyposulphite of Soda (see Section III.).	

Soda in the form of chloride of sodium or common salt is present in all the tissues and fluids of the body, and is introduced with all foods, existing as it does in them as part of their constitution, and being commonly added to many as a matter of taste. Perhaps it is on this account that soda does not have any peculiar action on any organ or tissue of the body.

What has been said of the salts of potash is true of those of soda, only to a less marked extent. Soda passes into the blood much less quickly than potash, and is on that account less used for its direct action on the blood, and more used for its action on the stomach and bowels, in cases of acidity and heartburn, &c. (see Section III.), though it may be employed in such cases as the potash preparations are used for. The bicarbonate is the preparation in most use. The phosphate and hypophosphite of soda are found in the compound syrups of hypophosphites because of their value in general nutrition.

Lithia.

Carbonate of Lithia	Dose, 3 to 6 grains.
Citrate of Lithia	,, 5 ,, 10 ,,

Lithia increases the alkaline character of the blood like soda and potash. Its special property, however, is the readiness with which the compounds it forms with uric acid dissolve. Now, excess of uric acid in the blood is supposed to be the cause of gout, and lithia is, therefore, given to ward off a threatened attack by removing the uric acid by the way of the kidneys, and to relieve an attack already begun. Deposits of uric acid in the kidney and bladder produce gravel—stone—and so lithia is given to dissolve the deposits and prevent the accumulation ever reaching the actual proportions of stone.

Magnesia and lime belong to the same class of remedies as potash, soda, and lithia, but as they are mainly used for their action on the digestive organs, they are noted in the section devoted to a consideration of the remedies that act on the digestive system.

As the natural alkaline character of the blood is increased by the use of potash, &c., so it might be to some extent diminished by the use of acids. They are not usually employed, however, to produce this effect, and they will be more suitably considered in the section on remedies acting on the digestive system.

Remedies which Cool the Blood—Antipyretics.

We are using rather a rough phrase when we speak of remedies which cool the blood, but the

sense in which it will be understood is sufficiently accurate. We take quinine as the type of these substances, and it has been already pointed out that quinine prevents the ready yielding up by the blood corpuscles of oxygen to the tissues, and so diminishes the process by which heat is produced, and thus actually a cooling action results. This effect is chiefly obtained when the heat of the body is above the proper standard, when fever is present. Substances which diminish fever are called **antipyretics**, from the Greek *anti*, against, and *puretos*, fever. **Antifebrile** is a word with a similar meaning, and **febrifuge** also. Another word applied to medicines used for a like purpose is **antiphlogostic**, from the Greek, *anti*, and *phlogōsis*, burning heat. Besides quinine, there are several other substances which diminish fever—salicine, antipyrin, antifebrin, kairin, &c., although the manner in which they act is not well understood. Besides the administration of such drugs, there are other means of lowering the temperature of the body, which will, therefore, be rightly counted as means of antipyretic treatment. Chief of these is the use of the cold bath, which acts by the direct abstraction of heat from the body. Other methods consist in acting upon the skin, so that the blood-vessels of the skin are dilated, more blood comes to the surface, it becomes thereby cooled, and the skin glands become more active, the increased perspiration which results leading to increased loss of heat. This effect is produced by alcohol and by digitalis. Then the kidneys may be stimulated to separate more urine, and thus increase the loss. While numerous other substances, such as aconite, veratrum, and so on, so depress the activity of the tissues that less heat is produced, and the rate of loss remaining the same, the body becomes cooled.

In this section we propose to consider only a few drugs, such as quinine, salicine, and antipyrin, which speedily lower fever heat in a special way not yet well understood. It is to be noted that these drugs, while they reduce or remove fever, have usually no effect upon the natural temperature of the healthy body.

Quinine is obtained from the bark of the cinchona tree, found in Peru, Bolivia, and Columbia, growing on the Andes, chiefly on the eastern face of the Cordilleras, at a height of from 4000 to 12,000 feet above the sea-level. The trees are now successfully cultivated in India, Java, Ceylon, and Jamaica. There are three chief kinds of cinchona, the pale cinchona, the yellow cinchona, and the red cinchona. The yellow cinchona (*Cinchona Calisaya*) is the richest in quinine, the red bark (*Cinchona succirubra*) contains it also, but the pale cinchona (*Cinchona Condaminea*) yields chiefly a substance called **cinchonine**, whose properties resemble those of quinine.

The Yellow Cinchona bark is the most important. It is obtained in quills or flat pieces of a tawny yellow colour. Reduced to powder it is sold under the common name **Peruvian Bark**, of cinnamon-brown colour, aromatic and bitter taste. The powder is not now much employed. The dose is 20 to 60 grains or more, but it contains tannin, and therefore produces an astringent action, and much of it is useless woody fibre. Moreover it is not so readily tolerated by the stomach, and since the desired effects can be got out of a very much smaller dose of quinine, the powdered bark is little employed.

Its preparations are:—

	DOSE.
Decoction of Yellow Bark.........	1 to 2 fluid ounces.
Liquid Extract of Yellow Bark...	10 ,, 30 drops.
Infusion of Yellow Bark...........	1 ,, 2 fluid ounces.
Tincture of Yellow Bark..........	½ ,, 2 tea-spoonfuls.

The Pale Cinchona occurs in quills, with a whitish, yellowish-white, or ash-gray coating. Its powder is pale brown. Its only preparation is:

Compound Tincture of Pale Bark....Dose, ½ to 2 tea-spoonfuls.

Besides bark, the tincture is made of bitter-orange peel, serpentary, saffron, cochineal, macerated in proof spirit.

The Red Cinchona is found in flat pieces, less frequently in quills, reddish-brown on the outer surface; its powder is red-brown. Tincture, liquid extract, &c., may be made of it, as of the yellow bark, the doses being the same. Tincture of the red cinchona bark has been very highly recommended in America to allay the craving for drink in habitual drunkards. It is given in tea-spoonful doses (see p. 105).

The cinchona barks contain four highly complex chemical substances, called alkaloids, namely quinine, quinidine, cinchonine, and cinchonidine; they also contain acids and a volatile oil.

Quinine is obtained from the bark by maceration with weak hydrochloric acid, and then adding a solution of soda, which precipitates it. The powder is then washed, dissolved by dilute sulphuric acid, and allowed to crystallize out of the solution, so that it is the sulphate of quinine that is usually obtained.

Its preparations are as follows:—

Tincture of quinine................Dose, 1 tea-spoonful and upwards.
(Each tea-spoonful contains 1 grain.)

Quinine Wine....Dose, 2 table-spoonfuls and upwards.
(Made with 1 pint of orange wine, 20 grains of quinine, and 30 grains of citric acid. An ounce, or two table-spoonfuls, contain 1 grain.)

Quinine Pill..................Dose, 3 grains and upwards.
(Each 3-grain pill contains 1 grain of quinine.)

Actions and Uses of Quinine.—Quinine acts on the stomach as a bitter tonic, when taken in small doses (½ to 1 grain), aiding the appetite and digestion, and being thus useful in states of general weakness, and in convalescence from acute disease. In large doses it may irritate the stomach and cause loss of appetite and sickness. It is its action on the blood with which we are here concerned, which, as already described, chiefly consists in binding the oxygen more firmly to the red blood corpuscles, and so preventing oxidation changes in the tissues, and lowering the heat of fever. For this purpose it requires to be given in large doses, 5 or 10 grains or even more, repeated if necessary. Such large doses produce peculiar effects on the nervous system, singing in the ears, deafness, a feeling of tightness in the head, giddiness, sometimes headache, and impairment of sight. By very large doses delirium is produced, and death might be caused, sometimes with convulsions. To these effects the term **quinism** or **cinchonism** is applied. In large doses quinine also weakens the heart, and slows the breathing. It is expelled from the body by the urine, and may irritate the bladder and urinary passage. It may stimulate the pregnant womb, and should, therefore, be given cautiously in this condition, lest miscarriage result.

Its most valuable effects are produced in such fevers as ague, and malarial fevers of all kinds, and in typhus fever, enteric fever, and fever due to blood-poisoning of other kinds. For ague, as a preventive, it is given in doses of 3 or 4 grains three times a-day, or, just before a fit is due, a single dose of 10 grains is best. For other fevers a single large dose may be given (10 grains or more) and repeated once in twenty-four hours, only if necessary, or two smaller doses (5 grains) may be given within one hour.

The influence which it has on fevers, recurring at definite periods—its **anti-periodic** effect, as it is called—extends also to other periodic affections, such as a neuralgia which tends to recur daily at a particular time. This may often be prevented by giving a 5-grain dose an hour or so before the usual hour of attack. Neuralgic headache it relieves, and with all the more certainty if it is combined with 20 grains of salicine.

Quinine, by a similar action to that which it exerts in preventing oxidation, prevents also fermentation, and it thus acts as an antiseptic, preventing the growth of minute organisms. Thus a dilute solution will preserve meat, milk, &c., for a length of time. On this account it is used as a gargle for ulcerated sore throat, and is added to tooth-powders.

The other substances named, cinchonine, &c., have similar effects but to a less extent.

Warburg's Tincture contains quinine with aloes, opium, rhubarb, camphor, and a number of aromatics, and is used for ague in doses of from one to four tea-spoonfuls.

Salicine is derived from the bark of the willow. It is also contained in poplar bark and in flower-buds of meadow-sweet.

Action and Use.—It reduces fever, and is specially employed in the treatment of rheumatic fever, being given in doses of 20 grains, repeated every two hours, till the fever abates and the pains disappear. When this has been accomplished, a powder should be given four times daily for several days to prevent a return of the attack. It is also very useful for neuralgia and neuralgic headaches, especially when combined with 5 grains of quinine.

Salicylic Acid may be derived from the oils of winter-green or sweet birch, but is usually derived from carbolic acid by heating with caustic soda and passing through it a stream of carbonic acid. It can also be obtained from salicine.

Its Actions and Uses resemble very much those of quinine. Thus, like the latter, it prevents putrefaction and decomposition, and is used largely for surgical dressings, for impregnating wool for surgical purposes. A mixture of 2 parts in 100 of tallow applied to the skin of the feet is useful in preventing sweating and soreness of the feet by walking. It is also employed as a lotion—4 parts to 100 of water—in irritation of the skin. Its internal effects are also like those of quinine, and produce like it noises in the ears, deafness, headache, and in large doses delirium. Like salicine it is used in acute and chronic rheumatism in doses of from 5 to 30 grains. But commonly a salt prepared from it, salicylate of sodium, is preferred.

Salicylate of Sodium..................Dose, 20 grains.
Used in the same way as Salicine.

Antipyrin is one of the most recent of the

antipyretic class of drugs. It is a patented preparation, made in Germany.

Action and Use.—It causes profuse perspiration, and in suitable cases reduces fever with great rapidity. For adults the full dose is 30 grains hourly for three hours, but it may be given in smaller doses—10 grains—every half-hour, when the desired effect will usually be obtained after three or four doses, and further administration is withheld till the fever again threatens to rise, when the same process is repeated. It has a sweetish-bitter, peculiar, but not unpleasant taste, and requires a good quantity of water to dissolve it. In typhoid fever, and in blood-poisoning, in scarlet fever and other fevers, it is particularly serviceable, and it may be given to children in almost any feverish complaint, to the extent of $1\frac{1}{2}$ grain for every year of the child's age, every hour for three hours. It may be sweetened for them. In the author's experience it is not so serviceable in reducing fever resulting from inflammation, such as inflammation of the lungs, inflamed tonsils, and the like. The influence of antipyrin on nervous headache is most surprising. The true nervous headache—megrim—will almost certainly be relieved within twenty minutes or half an hour by a dose of 10 or 15 grains. The person, after taking this dose, should if possible lie down in a quiet room. If relief is not begun, or is only slight, in twenty minutes, let a second dose be taken, and a third within other twenty minutes, if needful, and still a fourth, if required. If, however, these four doses fail to relieve, there is little use continuing the drug. In this drug, however, the person subject to periodic nervous headache, brought on also by the least excitement, shopping expeditions, &c., possesses a medicine that, in the author's experience, very rarely fails.

Thallin, used for fever in 5-grain doses, does not appear to be so good as antipyrin.

Antifebrin reduces fever quickly, and maintains the lower temperature for from three to seven hours, according to the quantity given. The dose is from 4 to 15 grains, not more than 30 grains being given in twenty-four hours. It slows the pulse, and often causes the patient to fall into a quiet sleep. In fevers generally, and specially in typhoid fever, rheumatic fever, and erysipelas, it is employed.

Kairin has a marked effect on fever, given in doses of from 3 to 30 grains. It is recommended that doses of 8 grains should be given every hour for four times or till the temperature has fallen to 100° Fahr. If the four doses have thus reduced the fever, 4 grains should be given every hour, should it appear necessary, but if the fever again rises, the larger dose is again given. It produces great sweating.

MEDICINES WHICH ACT ON TISSUE CHANGE.

Alteratives.

Alteratives, as already explained (p. 816), is the term applied to the drugs we are now about to consider, which improve the nutrition of the body by altering or modifying the chemical processes going on within the tissues, without producing any very perceptible action upon any organ or tissue in particular. The chief of these drugs are the metals, arsenic, mercury, iodine, and phosphorus, sulphur, and certain vegetable drugs, sarsaparilla, colchicum, guaiacum, &c. How these remedies act is not understood. They act slowly, without any apparent influence on the circulation, on the breathing, &c., and yet in time their effects appear. Their influence is brought to bear in the region of minute chemical change, at present beyond the reach of accurate scientific investigation. In time, however, the fact that they operate specially upon particular organs, though their modes of acting on these organs is unknown, becomes apparent. Thus arsenic specially influences the nutrition of the skin, mercury and iodine act specially upon glands and upon the nervous system, and so on.

Arsenic.—The chief preparations of arsenic are as follows:—

	DOSE.
Arsenious Acid (White Arsenic).....	$\frac{1}{60}$th to $\frac{1}{24}$th grain.
Liquor Arsenicalis (Fowler's Solution)	2 to 5 drops.
Arseniate of Iron........................	$\frac{1}{16}$th to $\frac{1}{8}$th grain.
Donovan's Solution (Solution of Arsenic, Iodine, and Mercury)...	10 to 30 drops.

Precautions in the Use of Arsenic it will be well to note first. As everyone knows arsenic is a powerful poison. Two grains of metallic arsenic have proved fatal, even when their administration was prolonged over five days. This quantity was taken as Fowler's solution, half an ounce of which it represents. Therefore arsenic should never be taken unless the dose and the manner of taking it is regulated by proper medical advice.

Arsenic should never be taken on an empty stomach, as it is very apt to produce irritating effects upon the stomach and bowels. It should, therefore, be taken only immediately after meals.

Arsenic should be taken only in very small doses to begin with. An ordinary dose of 5

drops of Fowler's solution given three times daily will produce, in many people, signs of irritation of the stomach, squeamishness, white silvery tongue, &c., whereas if a dose of 2 drops be given as frequently for several days, then 3 drops for a day or two more, and thus gradually the dose increased till the desired amount is reached daily, 12 to 30 drops, a tolerance will be established, and no signs of irritation produced.

When arsenic has been taken for a considerable period its use should not be suddenly stopped. A person who has been taking arsenic, in full doses, for a lengthened period, is likely when the need for it has disappeared to stop it all at once, as in the case of most drugs. This is a mistake. The sudden complete stoppage is apt to be followed, within even a few hours, by sickness, vomiting, headache, &c. Its use should be gradually stopped, even as it was gradually begun.

Arsenical Poisoning.—The symptoms of poisonous effects of arsenic are stomach pain, want of appetite, sickness, vomiting, diarrhœa, headache, silvery-white tongue, irritation of the eyes, and redness and swelling of the eyelids. If these symptoms arise in the course of using the medicine, the dose should be lessened; this is preferable to stopping the drug all at once. These symptoms are common in cases of chronic poisoning from the inhalation of vapour or dust containing arsenic. This used to be quite frequent, from the use of arsenic in the manufacture of wall-papers, to secure a brilliant green, and also from the wearing of articles of clothing, dyed with colours containing arsenic (see p. 732). This subject is considered at greater length in the next part, in the section devoted to poisoning.

Action and Uses of Arsenic.—Arsenic has a local effect upon the skin, used in the form of arsenious acid, which is for this purpose made up into a paste. It is employed to destroy growths. Its irritant action, when very mild, is occasionally made use of for stimulating the stomach. For this purpose very small doses are used, with the effect of aiding the appetite in certain kinds of indigestion. It is not, however, much employed for this purpose. Arsenic enters the blood and combines with the blood-corpuscles. It is sometimes used alone, or combined with iron, for bloodlessness—anæmia. It also is taken up from the blood by all the tissues and organs, remains in them for a short time, and is then cast off, being thrown off from the body by the urine, and to a slight extent also by the bile and skin. During its sojourn in the tissues it influences their chemical changes, the effect, when the dose is not excessive, being of a tonic and invigorating character. The arsenic-eaters of Styria, who begin with small doses, and are at length able to swallow 5 grains of arsenious acid at a time, do not suffer apparently, once they become habituated to the use of the drug, but present the appearance of strong healthy persons, and live to an old age. They have improved colour, increased muscular energy, and are able to climb the Styrian mountains without the breathlessness common to other people. *Some, however, die in the attempt to acquire the habit.* But the effects noted are due to the influence of the drug on tissue change. Arsenic is used in certain cases of bloodlessness, combined frequently with iron. Thus Blaud's pill (see p. 817) with $\frac{1}{60}$th grain of arsenious acid may be obtained of druggists, or the Fowler's solution with dialysed iron may be employed. Arsenic ranks next to quinine for its value in ague and malarial affections, and in affections exhibiting well-marked periods of recurrence, such as recurrent headache, periodic neuralgia, &c., it is very valuable. It is, therefore, said to be an anti-periodic. It is also used in nervous diseases, such as St. Vitus' dance and epilepsy. Its greatest employment, however, is in diseases of the skin, specially chronic diseases of the skin, such as eczema (p. 318), psoriasis (p. 319), &c. It has a special action on the skin, influencing the nutritive processes going on in a marked way. Very often it is combined with iron for this purpose, Fowler's solution, for example, with the compound iron mixture (p. 817). For skin diseases the solution of Donovan is also employed, combining the action of arsenic, iodine, and mercury, a combination much employed in skin affections dependent on syphilis. Finally, in chronic forms of lung disease, and in the early stages of consumption, its value is admitted, probably because of an improved condition of nutrition brought about in the lining membrane of the air-cells and fine tubes of the lung.

Mercury (Quicksilver) is a drug employed in a variety of forms and for very many purposes. Although we are considering it here for its influence on tissues, and its effect in bringing about an improved condition of general nutrition, still it will be well to note all its various actions and uses, to avoid considering it partly in one section and partly in another, though its effects on the bowel and liver, when given as blue pill, or as the cooling or "teething powder,"

with which probably everybody is familiar, will be further noted in the section devoted to drugs that act on the digestive system (section III.).

The chief preparations of mercury are as follows:—

	DOSE.
Calomel (Subchloride of Mercury)	$\frac{1}{2}$ to 5 grains.
Plummer's Pill (Compound Calomel Pill)	2 ,, 5 ,,
Gray Powder (Mercury and Chalk)	3 ,, 8 ,,
Blue-pill	3 ,, 8 ,,
(The size of pill usually sold by druggists contains 5 grains.)	
Blue Ointment (Mercurial Ointment).	
Corrosive Sublimate (Perchloride of Mercury: very Poisonous)	$\frac{1}{32}$th to $\frac{1}{16}$th grain.
Donovan's Solution (see p. 822).	
Red Precipitate Ointment (Ointment of Red Oxide of Mercury).	
Citrin Ointment (Ointment of Nitrate of Mercury).	
Black Wash (Lotion of Mercury). Made by adding 30 grains of Calomel to $\frac{1}{2}$ pint lime-water.	

Action and Uses.—Mercury is largely used as an application in the form of ointment or lotion to the skin. In the form of blue ointment it is used to destroy vermin. A solution of the corrosive sublimate is one of the most destructive agents of minute organisms, which are the cause of putrefactions and fermentations of various kinds, and is largely used in medicine and surgery as an antiseptic. Yellow precipitate and red precipitate ointment are common applications to chronic inflammatory states of the eyelids, as stimulant remedies. Lotions containing mercury are employed for the same stimulating effect, and as washes for ulcers, and sores slow to heal; calomel as a dusting-powder is used for the same effects. But ointments of mercury are very frequently rubbed on the skin, not for any effect to be produced on the part, but because they are absorbed from the skin into the blood and thus carried into the system. This method of administering the drug is called inunction. The usual course is to take a piece of blue ointment the size of a small bean and rub it well into the skin, in a situation where the skin is soft, such as the arm-pit or groin. This is continued daily till the effects of the drug manifest themselves. It is a method very applicable to children. A flannel bandage is put on the child, provided at one place with a small square pad, made of two or three folds of flannel, and sewed on the front part of the bandage. A small piece of ointment is smeared on this pad, and then the bandage is applied, the surface smeared with the ointment being next the skin. The bandage is fixed moderately tightly, and with the movement of the child the ointment is rubbed into the skin. Some newer preparations of mercury—the oleate of mercury ointment, for example—are more effective and active on the system than the old blue ointment, because they are more readily introduced through the skin. The usual method of administering mercury is by the mouth in the form of calomel, gray powder, blue-pill, solution of corrosive sublimate, or some of the more complex compounds of mercury, such as Donovan's solution, or the red or green iodides of mercury, compounds of iodine and mercury not named in the list given above. These substances are given by the mouth for one of two purposes: either to produce a purgative action and to influence the liver, or to be introduced into the system and to act upon the tissues generally. According to the effect desired is the form of drug prescribed, for, if a purgative action is produced, the most of the drug passes off in the motions and little enters the system. For the purgative effect calomel, gray powder, and blue-pill are commonly used. In the last two mercury is present in a metallic state, in a state of very fine subdivision. They appear to produce a purgative action by their local effect upon the stomach and bowels. They irritate the upper part of the small bowel, where the bile-duct from the liver enters (see p. 142), and thus cause the bile to be poured out of the liver into the bowel, although it would appear that mercurial preparations do not actually cause the liver to prepare more bile from the blood than it would otherwise do. They cause the liver, however, to deliver up its bile, so to speak, and then it is rapidly passed down the bowel by the quickened action of the bowel and expelled before much of it can be reabsorbed into the blood. A saline purgative, say a seidlitz-powder, given a few hours after a blue-pill, will thus aid its action by producing a flow of watery material into the bowel to wash it out more effectually. This is the reason for a blue-pill at night being followed by a seidlitz-powder in the morning. Gray powder is the form in which mercury is administered to children, for looseness of bowels, accompanied by the passing of greenish or curdy motions. While in many cases it is the appropriate remedy, it is given far too frequently and far too indiscriminately.

When the effect of mercury upon the system is desired, either some means is taken to prevent the purgative action of the calomel or blue-pill, or other preparations of mercury with less of a purgative action are employed, and especially the solution of perchloride of mercury (corrosive sublimate).

The action of mercury on the system is pro-

found, though obscure. It is taken up from the blood by every organ of the body, and specially by the liver, and it may remain in them for an indefinite period, so as to be detected in them after death. During its residence it influences in some unknown way the minute nutritive changes going on. It is removed from the body in the urine, bile, sweat, and is found in the saliva from the mouth and in the milk. Its most marked effects are shown as the result of the alterative action on the tissues. Thus organs which are the seat of inflammatory deposits or overgrowths are very often rid of the abnormal state of things by a prolonged use of mercurial treatment. In no disease is this so marked as in those dependent upon the syphilitic poison, attended by the multiplication of small cells among the tissues, specially of the nervous system and skin, little tumours being in time formed which by pressure on nerves, &c., produce paralysis and the multitudinous kinds of symptoms seen in this disease. The action of mercury, when appropriately and timeously given, is to dissipate these growths and effect a cure. It is also employed to aid the absorption of inflammatory thickenings, not necessarily syphilitic, as for example such as result in the cavity of the belly from peritonitis (see p. 190).

Precautions in the Use of Mercury.—When mercury is given in excessive doses injurious effects speedily show themselves. The first part of the body to suffer is usually the mouth. The gums become tender, red, and swollen; an unpleasant metallic taste is felt in the mouth, which is also hot. The breath is foul, the tongue thickly coated, and the appetite gone. The flow of saliva is increased and the glands at the side of the face enlarge and are painful. If the use of the drug is continued, ulcers form in the mouth, the tongue becomes swollen so that the person cannot speak, the teeth become loose, and chewing becomes impossible. There are also chilliness, a feeling of general depression, and perhaps vomiting, purging, and bloody stools. **Mercurialism** is the term applied to these effects; and the action on the salivary glands, resulting in swelling and the constant dribble of saliva from the mouth, is called **mercurial ptyalism.** In very bad cases death of part of the jawbone may occur. When persons are exposed to the action of mercury in small doses for a long time, another kind of effect may be produced, a condition of general enfeeblement, thinness, pallor, dyspepsia, muscular tremors and rheumatic pains, tendency to fainting, and palpitation, and impairment of sight and hearing may occur. This kind of symptom has been found in those exposed to the fumes of mercury in certain manufactures. Many persons are more liable to the influence of mercury than others. Even a single grain of calomel has been known to produce in an adult all the marked symptoms connected with the mouth. Persons cannot, therefore, be too careful in dosing themselves with mercurials, and it is very curious how often one meets with persons who have pronounced objections to be treated with what is vaguely called "metallic remedies," with whom the use of blue-pill at regular intervals is yet almost a passion, and whose children are dosed, on the smallest excuse, with "cooling powders" or the like. These persons are very much astonished to learn that blue-pill and gray powder are formed of metallic mercury very finely divided up. The marked effects of a debilitating kind shown on excessive use of the drug, or in persons very susceptible to its action, exist to a modified degree even when the dose is not excessive, and must be met by the administration of good food and by strict attention to the conditions of health, fresh air, &c.

Iodine is obtained chiefly from kelp, the ashes of sea-weed, and it is present in sea-water.

Its preparations are as follows:—

Liniment of Iodine.
Liquor of Iodine.
Tincture of Iodine.
} These are used for external application.

Iodine Ointment.
Iodide of Potassium................Dose, 2 to 10 grains.
Syrup Iodide of Iron............... ,, 20 to 60 drops.
(60 drops contain 4½ grains Iodide of Iron.)

Actions and Uses.—Iodine is used externally for its powerful irritant action on the skin and mucous membranes, being applied for its stimulating property and also for a disinfectant property to foul and discharging sores. It is also applied to the healthy skin for the purpose of acting on it much as a blister does, and so to bring the blood to the surface and relieve deeper parts. Thus it is often painted over the skin of inflamed joints after the acute inflammation has passed, for the removal of thickening, &c., in the joint, and on the chest following pleurisy and inflammation of the lung, to promote absorption of fluid or inflammatory products. It is used on the skin over enlarged glands, *when there is no active inflammation going on in the gland.* In the case of joints and chest affections, blisters are, in the author's opinion, much more useful, and in the latter case better results are obtained, without staining and injury of the skin, by the internal use of iodide of potassium or

syrup iodide of iron. The preparations used for external application are the liniment, the liquor tincture and ointment. The liquid preparations are most commonly diluted with glycerine. It is injected in the form of tincture into the sac of a hydrocele to prevent reaccumulation of fluid, and for a similar purpose in spina bifida (p. 457). When administered internally, the preparation of iodine enters the blood and passes to all the organs of the body. It is expelled from the body with great rapidity, specially in the urine, but it also appears in the secretion from the nostrils, in the sweat, in the saliva and in milk, and it may irritate the organs chiefly concerned in separating it, specially the nostrils, salivary glands, and skin. When the irritation is marked symptoms, classed together under the term **iodism**, are produced. The chief of these are running at the eyes and at the nose, pain in the forehead, and sensations connected with the nose and forehead resembling those of a common cold. There are also tenderness of the gums and mouth, increased flow of saliva, a feeling of rawness in the chest, and perhaps loss of appetite and sickness, and there is increase of mucus from the air-passages. A skin eruption occurs with some persons. While iodine is found in all the tissues of the body, it is found particularly in lymphatic glands, and secreting organs, salivary glands for example. Its most common employment is because of the effect it produces on these organs after prolonged use. In the case of thickening and enlargement of the glands, it produces absorption of thickenings; and, after a long time, it may even cause a wasting (atrophy) of the glands themselves. Indeed the quickening effect it induces on tissue change is taken advantage of to promote the absorption of effusions of fluid and inflammatory thickenings in any part of the body, but specially in connection with joints, and the cavities of the body. Thus it is frequently employed to aid the removal of the fluid in pleurisy, and other dropsies, and the inflammatory products in inflammation of the brain, water-in-the-head, &c. In scrofulous affections of glands, and scrofulous thickenings in general, it is invaluable, the best form for children being the syrup iodide of iron. In the later manifestations of syphilis, particularly its nervous manifestations, it is largely resorted to. The intense and continuous headache and the night pains of syphilis yield in a surprising manner to iodide of potassium, which is, in this instance given in large doses, 30, 60, and even 90 grains daily, if it can be borne, for it is a remarkable circumstance that large doses, 10 grains and upwards, are borne more readily than small ones, 2 to 5 grains.

Iodine forms easily-dissolved combinations with lead and mercury, and therefore it is administered in cases of chronic lead and mercury poisoning, for the sake of combining in the tissues with these metals and so securing their removal from the body. It is used in chronic rheumatism, and in large doses in aneurism.

Care should be taken that anyone being treated with iodide of potassium or iodine in other forms has abundance of easily-digested and nourishing food.

Phosphorus is obtained from bone-ash, in which it exists combined with lime.

Its principal preparation is:

Phosphorus Pill..........Dose, 1 to 3 grains, containing $\frac{1}{30}$ to $\frac{1}{10}$ grain of phosphorus.

Actions and Use.—Phosphorus has a marked effect on tissue change. In very small doses, given for a long time, it has been shown to act upon bones, increasing the amount of dense bone formed. In larger doses it leads to fatty degeneration of tissues, and, in cases of poisoning by phosphorus, extensive fatty change of liver, muscles, heart, and other organs is found. This is due to albuminous substances being broken down into a nitrogenous and a fatty portion, and the fatty portion being prevented uniting with oxygen. Phosphorus is administered in cases of nervous disease, nervous debility, neuralgia, paralysis, sleeplessness, being given as pill, or in combination with other drugs, such as zinc, with which it forms phosphide of zinc, of which the dose is $\frac{1}{8}$th to $\frac{1}{3}$d grain in pill. Then it is a common ingredient in the various compound syrups, used for general debility, lung diseases, and so on, in the form of phosphate of lime, or hypophosphite of lime, soda, &c.

Sulphur.—The principal preparations of sulphur are:—

Flowers of Sulphur (Sublimed Sulphur)..............................Dose, 20 to 60 grains.
Confection of Sulphur, or Sulphur Electuary: Flowers of Sulphur, 4 oz.; Cream of Tartar, 1 oz.; Syrup of Orange Peel, 4 oz. This is the same as the time-honoured "sulphur and treacle," treacle or ordinary molasses syrup being used instead of syrup of orange peel.....Dose, 1 to 2 tea-spoonfuls.
Sulphur Ointment (Flowers of Sulphur, 1 oz.; lard, 4 oz.).
Chrisma Sulphur.
Milk of Sulphur (Precipitated Sulphur)..............................Dose, 20 to 60 grains.

Action and Use.—Sulphur is used as a local application in the form of ointment for skin

diseases, and in particular for such as depend on parasites, such as itch. It appears that it is not the sulphur, as such, which is of value, but, in contact with the skin, compounds of sulphur are formed, namely sulphurous acid and sulphuretted hydrogen, which are destructive to the life of minute organisms. Sulphurous acid is liberated, as a gas, when sulphur is burned, and is liberated thus for purposes of disinfection; and sulphuretted hydrogen is also a gas, of nauseous foul smell. The smell of rotten eggs is due to the presence of sulphuretted hydrogen, produced from the decomposition of the albumin of the egg, for albumin contains sulphur in combination. Sulphurous acid in solution has been employed as a paint or spray for the throat in diphtheria, in the hope of destroying the fungus of the diphtheritic membrane, and sometimes with apparent success.

When sulphur is taken internally it stimulates the bowel and produces, without pain, an easy soft stool. It is, therefore, used as a laxative whenever there are conditions of the bowel, or neighbouring organs, in which more active purgatives would do harm, in cases of piles, for example, and pregnancy, &c. For this purpose the sulphur electuary is most valuable. Sulphur waters, such as those of Moffat and Strathpeffer in Scotland, Harrogate in England, Aix-la-Chapelle, Aix-les-Bains, Eaux-Bonnes, and others abroad, are used for similar purposes, as well as for other effects to be noted. These waters contain sulphur in the form of sulphuretted hydrogen or as salts, like sulphide of potash, &c. Sulphur when taken internally enters the blood as sulphuretted hydrogen, or salts, and is expelled from the body in the urine, and also by the breath and sweat. The breath may have the disagreeable smell of sulphuretted hydrogen on that account, and any silver articles worn about the person, silver coins carried in the pocket, &c., will be blackened by the sulphur excreted by the skin. In large quantities the sulphur compounds named act upon the nervous system in a depressing way, and it is perhaps owing to this that sulphur waters produce headache and depression on some persons. Having entered the blood the compounds reach the tissues, and modify their action in some unknown way. Because of this action, they have gained a repute in chronic rheumatism, gout, syphilis, and skin disease; while because of the laxative effect of sulphur waters, they are largely resorted to by those suffering from constipation and liver disorders.

Within recent years, Dr. Bergeon, of Lyons, has advocated the treatment of consumption and other lung diseases by injecting into the bowel carbonic acid gas, charged with sulphuretted hydrogen. A special apparatus has been designed for the purpose. It consists of a wide glass bottle in which a solution of soda is placed. To this is added tartaric acid. Carbonic acid is produced in large quantity, and is carried by a tube, guarded by a valve, to an india-rubber bag. From this bag a tube leads to a bottle containing a sulphur water, such as Eaux-Bonnes, or a solution of a sulphide from which sulphuretted hydrogen is liberated by the addition of a little of a solution of tartaric acid. The tube from the bag pierces the cork and dips down below the surface of the solution. The cork is pierced by another tube, which terminates, however, just inside the bottle, and this tube communicates with an elastic bag, similar to that of an enema syringe. From the other end of this elastic bag a tube passes off, the end of which is of a kind fitted for passing up into the bowel. When the elastic bag is squeezed any gas it contains is forced into the bowel, and when the pressure is relaxed carbonic acid gas is drawn into it from the india-rubber reservoir, bubbling through the solution of sulphuretted hydrogen on its way. The sulphuretted hydrogen is absorbed by the blood-vessels of the bowel, carried through the liver to the right side of the heart, and thence to the lungs, from the air-cells of which, according to Bergeon, it is expelled. His view is that as it thus passes through the lung tissue, it exerts an action upon the organisms of consumption destructive to their activity, a disinfectant action, and produces a healing influence on the diseased parts of the lung. The treatment has been highly praised abroad, and some good results have been said to follow its use by English physicians. It is only, however, in the early stages of the disease, and in slow chronic cases, that its beneficial effect is found, and it does not seem to retard at all the progress of acute cases, cases of galloping consumption. This latter fact the author has verified, as in a few cases of this kind in which he was able to have the method daily employed for many weeks, no benefit followed. The process of injection is somewhat tedious, half an hour to one hour being required each time; and it should be done certainly once, and, if possible, twice daily, about 2 pints of gas being injected each time. The bowel is thus filled with gas, and considerable discomfort is at first produced, aggravated by an almost unavoidable resistance on the part of the patient. After a

little experience, however, the discomfort is readily borne, resistance ceases, and the injection becomes very much easier. The process can be easily performed by a nurse, or anyone of average intelligence, after the method has been seen in action once or twice, so that after a day or two of practice the patient's friends can themselves carry out the treatment readily.

Sulphuretted hydrogen is a poisonous gas, and if inhaled in sufficient quantity will cause death by suffocation. Accidents of this kind have occurred to men entering cesspools for cleaning purposes, when they have been charged with the gas from decomposing materials. The breathing of air containing any quantity of the gas produces loss of appetite and headache in most people. In the use of the injection for consumption, therefore, the bottles should be kept well corked to prevent escape of the gas into the apartment, and if the gas is being expelled from the bowel, almost as soon as it is injected, one should proceed slowly till the bowel gets accustomed to the treatment, or stop altogether for a time. It is a remarkable fact that injurious effects from the gas are never produced on the patient, the explanation offered being that all the gas absorbed from the bowel passes into the venous system, and that the blood passing through the lung before it is distributed through the body is freed of the gas, which thus never reaches the tissues, and has no opportunity of exerting a poisonous effect.

Sarsaparilla is the dried root of a Jamaica plant.

Its preparations are:

	DOSE.
Decoction of Sarsaparilla	2 to 10 fluid ounces.
Compound Decoction of Sarsaparilla	2 ,, 10 ,, ,,

(Made of 2½ ounces Jamaica sarsaparilla, cut into pieces, sassafras in chips, guaiac wood turnings, and fresh liquorice root, bruised, of each ¼ ounce, mezereon, 60 grains, boiling distilled water, 30 ounces, evaporate to a pint.)

	DOSE.
Liquid Extract of Sarsaparilla	½ to 4 tea-spoonfuls.

Sarsaparilla had, of old, a high repute in the treatment of blood disorders, and especially in the treatment of syphilis, chronic diseases of the skin, gout, scrofula, and rheumatism. It is now practically neglected by most physicians, though as a domestic remedy it is still thought highly of. It appears to stimulate the skin and kidneys. It is given also along with iodide of potassium, and the beneficial effects it was believed to have on the system generally are supposed to be mainly due to such drugs combined with it.

Colchicum or Meadow Saffron yields several preparations, used in medicine, and derived either from the sliced corm or bulb, or from the fully ripe seeds.

Preparations:

	DOSE.
Extract of Colchicum (from the bulb)	1 to 3 grains.
Extract of Colchicum with Acetic Acid (from the bulb)	½ ,, 2 ,,
Wine of Colchicum (from the bulb)	10 ,, 30 drops.
Tincture of Colchicum (from the seeds)	10 ,, 30 ,,

Action and Use.—Colchicum increases the quantity of bile expelled from the body, and also causes an increase of perspiration. When the dose is too large it irritates the stomach and bowels, producing vomiting and purging, and great prostration. The heart is weakened, and breathing diminished, and the nervous system is depressed. Its main use is in gout, in acute attacks of which it is regarded as almost infallible, though it sometimes fails to afford relief. It markedly relieves the inflammation and pain, for which purpose ½ to 1 tea-spoonful of the wine may be given. It has been shown that while it does this, the effect produced is temporary, as the drug does not relieve the system of the cause of gout, the excess of uric acid in the blood and tissues, and, therefore, does not prevent a return of the attack. Thus the use of drugs such as lithia and potash which remove the uric acid are preferred, and "gout-ridden sufferers commonly advise their fellow-sufferers to abstain from colchicum." It is said to act best when administered with medicines, such as sulphate of magnesia (the ordinary "salts"), which produce a purgative action.

Guaiacum is used as a wood—*lignum vitæ*, and as a resin obtained from the tree stem.

From the resin the following are made:—

Guaiac Mixture..........Dose, 1 to 1½ fluid ounce.

(Made of powdered guaiacum, ½ ounce, sugar, ½ ounce, powdered gum arabic, ¼ ounce, cinnamon water, 1 pint.)

Ammoniated Tincture of Guaiacum..........Dose, ½ to 1 tea-spoonful.

Action and Use.—Guaiacum stimulates the lining membrane of the mouth, throat, and stomach, when taken internally, producing a feeling of heat in the mouth and stomach, and stimulating the movement of the bowel, causing purging, in large doses severe vomiting and purging. It also stimulates the heart by nervous influence. Entering the blood it excites the skin and kidneys, the liver, and tissue change in general. It is highly spoken of in the treatment of sore throat, quinsy, for which

it may be given in powder, 30 grains placed on the tongue and slowly swallowed, every six hours, or as the mixture, or in the form of lozenges, each of which contains 2 grains. In chronic rheumatism and gout it has been used with much success, the ammoniated tincture being advised.

Mezereum is the dried bark of *Daphne Mezereum*, or *Daphne Laureola*, the spurge laurel. In small doses it acts on the skin and kidneys, but in larger doses is a marked irritant, producing purging and vomiting. It is used in chronic rheumatism, scrofulous and skin disease, but is practically unknown in this country, except as an ingredient of the compound decoction of sarsaparilla (p. 828). As a liniment in combination with mustard and as an ointment it is employed externally.

SECTION II.—DRUGS WHICH ACT ON THE HEART AND BLOOD-VESSELS.

Drugs which Act on the Heart.

Heart Stimulants:
- *Ammonia*—Its Preparations and Use in Fainting;
- *Ether;*
- *Camphor;*
- *Alcohol*—How to Employ it as a Medicine.

Heart Tonics:
- *Digitalis*—Its Value in Weakness and Irregularity of the Heart;
- *Squills; Lily of the Valley* (Convallaria majalis);
- *Strophanthus hispidus.*

Heart Sedatives—Drugs which Soothe the Heart·
- *Aconite*—Cautions Requisite in its Use.

Drugs which Act on the Blood-vessels.

Drugs which Contract the Blood-vessels:
- *Ergot of Rye*—Its Use in Internal Bleeding;
- *Witch-Hazel* (Hamamelis virginica);
- *Acetate of Lead.*

Drugs which Relax the Blood-vessels:
- *Nitrite of Amyl*—Its Employment in Asthma.

Anyone who reads the 8th Section of the First Part of this work with understanding will appreciate the primary importance of a healthy condition of the blood, by which all the tissues and organs are maintained in a condition of activity, and will perceive the paramount necessity of the blood being distributed to the whole body with due regularity and in sufficient amount. It will matter little that the blood is of excellent quantity if it does not reach the tissues in a regular stream, nor will the body as a whole exhibit the evidences of a general well-being, if the blood lingers in overcharged vessels in one organ, while another is half-starved from a defective supply. The dependence of the body, therefore, upon the condition of the heart, which supplies the motive power for driving the blood through the body, and of the vessels, which are the channels of distribution, is fully evident. Speaking broadly, disorder of blood distribution will depend upon one of two circumstances: either the force-pump, the heart, is working improperly—too feebly or too strongly or irregularly; or, while the heart is working properly, the vessels are the cause of disturbance—contracted in calibre it may be, and thus opposing too great resistance to the onward flow of the blood, or relaxed and permitting too free a flow in one direction or another, tending to create some local congestion, or other disorder; or, of course, some element of disturbance may exist in both. The study of remedies which can be brought to bear upon the heart and blood-vessels will, therefore, be one of much interest. We shall, then, consider some of the chief drugs which act upon the heart and vessels, and the objects which may be gained by their use.

DRUGS WHICH ACT ON THE HEART.

Drugs which act on the heart may be roughly divided into those which stimulate the heart, which brace or tone the heart, **heart tonics**, and

stimulants, and drugs which quiet or soothe the heart, **heart sedatives, or heart depressants.**

Heart Stimulants and Tonics.

The heart is a muscular organ, the fibres of which are so arranged that, when they contract, the size of its cavities is diminished by a ringing or twisting movement, and the blood driven out into the vessels. If this movement be feeble, the heart will not be properly emptied with each contraction or beat, and the vessels will not be properly filled. The nutrition of the body will be imperfectly carried on. A good illustration of such a consequence, arising suddenly, is fainting or syncope. The heart is from some cause suddenly enfeebled, or its action almost arrested, and the brain being deprived of its needed supply immediately suspends its functions. If the cause be some momentary shock, the heart's beat is gradually restored, the circulation in the brain becomes re-established, and consciousness returns. Or if a stimulant be applied in some way to the heart so as rapidly to excite its activity, consciousness returns, and the colour returns to the face, pale from want of blood. Enfeebled action of the heart, whether brief, as in this case, or more long-continued because of some other condition, leads not only to failure of nutrition of the body, but also to defective nutrition of the heart itself. For the heart itself is supplied with blood by two arteries, the coronary arteries, which are the first branches to come off the main distributing vessel, the aorta (p. 223). So that if the heart is feebly propelling blood into the vessels, the heart is the first sufferer, and any long-continued feebleness will inevitably tend to perpetuate itself, because of the failure of the heart-substance to receive due nutrition.

Now the heart muscle may be stimulated directly, but is specially acted on, like other muscular organs, through the nervous system. Within the substance of the heart are nervous structures whose business it is to maintain the steady rhythmic movement of the heart. These may be acted upon and excited by remedies, administered and gaining access to the blood. These nerve ganglia, as they are called (for the meaning of ganglia see p. 85), are in turn controlled in their action by two nerves, the pneumogastric (p. 225), which restrains their action, so as to cause a slowing of the heart's beat, and, if excessive, a stoppage of the heart in a state of complete relaxation, and the sympathetic (p. 225), which excites them, and inceases the rapidity of the heart's action, leading, if excessive, to stoppage of the heart in a state of firm contraction. Acting, then, through one of these channels, stimulants increase the force and frequency of the heart's contractions.

Heat is one of the best and most rapidly acting of heart stimulants, whether in the form of a hot liquid taken into the stomach, or in the form of a hot sponge applied over the heart, or a hot-water bottle, similarly placed. It is exceedingly useful when it is necessary to act immediately, as in fainting or sudden collapse. It is drugs, however, we wish to consider specially, and the drugs which stimulate the heart are chiefly ammonia, ether, camphor, and alcohol.

Ammonia is a gas, used as a solution in water, from which it rapidly passes off. When one smells liquid ammonia, it is the gas coming off which produces the hot pungent sensation in the nostrils.

The chief preparations are:—

	DOSE.
Strong Liquor Ammonia	2 to 5 drops, well diluted.
The weaker solution to be preferred, if taken internally.	
Ammonia Water, or Liquor Ammonia	10 to 20 drops, well diluted.
Made with 1 oz. of the strong liquor to 2 ozs. of water.	
Sal Volatile, or Aromatic Spirit of Ammonia	½ to 1 tea-spoonful.
Liniment of Ammonia, Ammonia water, 1 oz.; olive oil, 3 ozs.	
Carbonate of Ammonia	3 to 10 grains.
Chloride of Ammonia	5 ,, 20 ,,
Solution Acetate of Ammonia (Mindererus' Spirit)	2 to 6 tea-spoonfuls.
Bromide of Ammonia (see Section on Drugs which Act on the Nervous System).	

Actions and Uses. — Ammonia acts as a stimulant to any surface to which it is applied. If applied to the skin it causes a hot burning sensation, and produces redness, and is, therefore, used as a liniment to rub over stiff joints, muscles, &c. If it is applied on a cloth and covered up, it will blister. But it is not usually employed for this purpose. It may be used to destroy the poison of snake bite, or to relieve the sting of insects and nettles—the weak solution. Raspail's sedative solution, used as a lotion for headache in women who suffer because of some womb derangement, is made with 2 ounces ammonia water, 2 ounces of common salt, 3 drachms camphorated spirit of wine, and 32 ounces of water. When applied to the nostrils as smelling-salts, or when the solution is sniffed (the weak solution should be used), the vapour of ammonia irritates the nostril, it excites the action of the heart, through the nerves, quickens

the pulse, and also quickens the breathing. It should not be used for too long a time for this purpose. A solution of any strength ought not to be held beyond an instant or so under the nostrils of an unconscious person, as the irritating vapour might inflame the nostrils and even the lining membrane of the lung tubes and lead to bronchitis. Taken into the stomach, it acts there also as a stimulant, but if used very strong or in too large quantities may occasion inflammatory action, and even cause death by its powerful effect arresting the breathing. Given in proper doses it not only stimulates the stomach, and produces a sensation of warmth, but it stimulates the action of the heart, even before any has time to be absorbed and act on the heart through the blood. The carbonate is the best preparation to give for this purpose. Its action on the stomach and bowel makes it useful for colic and flatulence. Carbonate of ammonia in 5-grain doses, with 5 to 10 drops of tincture of cayenne, and an ounce of infusion of calumba or other bitter infusion, is recommended to relieve the craving for spirits, and as a stimulant in cases, specially in women, when feelings of sinking and depression are felt. Carbonate of ammonia has also been used in scarlet fever, to diminish the fever and delirium, and has gained high repute, being given in 3 to 5 grain doses every two or three hours. Besides acting on the heart, ammonia acts as a stimulant to the bronchial tubes, increasing the action by which matters are swept up the tubes, and is, therefore, very valuable for aiding the expulsion of matter from the lungs, as in bronchitis when there is much expectoration. Its effect on the heart makes it specially useful in such cases. Given in the form of solution acetate of ammonia, it acts on the skin as a stimulant, promoting sweating; and this is a very simple and harmless preparation to give to children in feverish complaints, to promote sweating and diminish the heat of the body. Chloride of ammonium has been largely used in chronic cases of liver congestion.

Ether is discussed in the section devoted to drugs acting on the nervous system, along with chloroform. It may be used in cases of urgency to excite the heart or to dispel wind in the bowels in nervous and hysterical women. Of the ether itself, 20 to 60 drops are the dose given diluted or injected into the bowel, or the spirit of ether in 30 to 60 drop doses.

Camphor is a volatile oil, obtained from the wood of *Cinnamomum Camphora*, and imported from China and Japan.

	DOSE.
Camphor	1 to 10 grains.

Preparations :—

Camphor Water (Tie ½ ounce crushed Camphor in a muslin bag, and leave in 4 pints of water for at least 2 days.)	1 to 2 fluid ozs.
Camphor Liniment (1 oz. camphor, 4 ozs. olive-oil).	
Spirit of Camphor	10 to 30 drops (in milk or on sugar).
Paregoric Elixir, Compound Tincture of Camphor (Contains opium.)	15 to 60 drops (for adults).

Actions and Uses.—Camphor stimulates the skin, and is therefore used for liniments and ointments to relieve stiffness of muscles and joints, for sprains, &c. It stimulates the stomach, and is useful for dispelling wind, specially in hysterical subjects; but in large doses it irritates the stomach and causes sickness and vomiting, with a burning sensation at the pit of the stomach. The stimulating effect on the stomach and bowels renders it most valuable in cases of summer diarrhœa, attended by cramp. It is recommended in the form of spirit of camphor, 4 to 6 drops, on sugar or in milk, every ten minutes till the improvement occurs, and in 1 or 2 drop doses it is given to children in milk in like disorder of the bowels. At the very beginning of a cold in the head, the sniffing of camphor, or taking a dose by the mouth, very often relieves. For its stimulating action on the heart it is resorted to in fevers producing prostration. It strengthens the pulse and moistens the skin, checking delirium. It also stimulates the nervous system, but in excessive doses produces great excitement and convulsions, and if the dose be very large may cause death.

Alcohol.—The question of alcohol has been already discussed sufficiently (see p. 668). In the form of whisky or brandy it is usually most frequently at hand in cases of fainting. To relieve or ward off a fainting attack a small quantity, strong, is better than when it is much diluted, for the stimulating effect of the strong spirit on the mouth and stomach excites the heart even before any has had time to pass into the blood. In weak conditions, whether whisky is having a beneficial effect or not upon the heart can be determined by the state of the pulse, skin, tongue, breathing, &c. If the quick hurried pulse of fever is steadied, and slowed, while made stronger, if the breathing is quieter and more regular, if the skin is more cool and moist, and the tongue less dry and parched, and sleep is induced, the alcohol is having a good

effect. But if the pulse is more hurried, the patient more restless, the heat of the skin greater, it ought not to be continued. The effects it produces should be carefully watched for some time after a dose has been given to enable one to determine whether it should be continued or not. "Particular care should be taken in the administration of alcoholic stimulants to patients in the small hours of the morning. It is about this time that attendants are most apt to become sleepy, and therefore careless, and just at this time, also, the external temperature is lowest, the fire is apt to get low, and the vital powers of the patient are most likely to sink. In giving alcoholic stimulants to support the strength in disease, care must be taken that they are not given so frequently and in such large quantities as to disorder the stomach. Sometimes, when given very freely to support the failing circulation, they have this effect; the result of which is that both food and stimulants are vomited, and the patient may be brought to death's door." If whisky or brandy is found to be doing good the attendant is too apt to push its administration too far in the eagerness to secure the utmost advantage. This can only be avoided by a carefully accurate record being kept of the quantity used in 24 hours. It is not desirable to administer it in large quantities at long intervals, but in small quantities at short intervals. A very good way of accomplishing this is to give it in milk. Let a table-spoonful be mixed with a tumblerful of milk and kept covered, and let the patient receive sips of this every little while, every quarter or half hour, as may seem demanded. The quantity used in 24 hours is then counted as tumblerfuls of milk. A table-spoonful is $\frac{1}{2}$ oz. Now we have seen that, in health, 2 ounces of whisky or brandy is about the quantity that can be effectually disposed of in 24 hours, that would be 4 table-spoonfuls. But in disease very much larger quantities can be consumed without producing any sign of bad effects. Indeed children, even infants, can often take that quantity and above it, without being in the least affected by it. Larger quantities are, therefore, often demanded, specially in such cases as inflammation of the lungs accompanied by weak and failing action of the heart, bronchitis, and indeed in any diseases which imply a great strain upon the vital powers. It is remarkable how young children take this mixture of whisky and milk, and how often it seems to be the most beneficial thing to give in bronchitis with a great amount of material in the lungs, &c. For them the dessert-spoonful to each small teacupful of milk would be sufficient, and four or upwards of them might be used in 24 hours. Alcohol may often be replaced by such a stimulant as ammonia, but ammonia quickly passes through and escapes from the system, so that its action is short-lived, while the effect of spirits lasts for a considerably longer time, and can, therefore, be maintained more steadily and readily. Alcohol ought not to be employed in cases of nervous prostration, neuralgia, hysterical affections, sleeplessness. The risk of its use being continued, and continued to excess, and beyond the time of need, in all cases where the stimulant must be given for some time, or where the affection recurs at regular periods, is so great that it is better to seek some other means of producing the effect desired. In no class of cases is this more apt to occur than in women who suffer from nervous or hysterical attacks, or who are liable to regular periods of depression or pain at stated times. Every medical practitioner has met with cases where inveterate drunkenness has been traced to an illness when stimulants were given by medical orders, and when they were continued long after the order to give them was withdrawn.

Of **heart tonics** the chief are digitalis, squills, lily of the valley, and the most recent is strophanthus, the African kombé or arrow-poison.

Digitalis.—The leaves of digitalis, or the purple foxglove (see Plate XI.), are the parts of the plant used in medicine.

The preparations are:—

	DOSE.
Tincture Digitalis	5 to 30 drops.
Infusion of Digitalis	2 ,, 4 tea-spoonfuls (drachms).
Digitalin (the active principle)	$\frac{1}{60}$,, $\frac{1}{30}$ grain.

Action and Uses.—Digitalis acts upon the heart by increasing the force of its beat and lessening its frequency. Its effect is thus of a tonic character. At the same time it stimulates the nerves acting on the blood-vessels, diminishing their calibre. The heart is thus emptied at each beat more completely, the arteries are better filled, and are kept so by their diminished calibre, and the circulation is thus made more effective. The feeble heart is strengthened, and in cases where the beat is irregular, now fast now slow, now strong now weak, an occasional beat being missed and this being followed by a series of short, quick, feeble, fluttering, beats, its effect in appropriate doses is most marked and beneficial. The great disadvantage of digitalis is its tendency to derange the stomach and bowels, to produce loss of appetite, heartburn, vomiting, and sometimes diarrhœa, an

effect partly due to an irritating action on the lining membrane. This is one of the great difficulties in the use of the drug, for a patient cannot afford to have digestion deranged and disturbance of the first step in the nutrition of the body interfered with. In too large doses it produces irregularity of the heart's action, and poisonous doses cause death by stopping the heart. The drug has also a marked effect upon the kidneys, the result of which is greatly to increase the amount of urine passed.

The two purposes, then, for which digitalis is used are for affections of the heart, either when the heart is irregular in action from feebleness, when there is palpitation, or in certain cases of actual disease of the valves of the heart, and for cases of dropsy, because of its action on the kidneys. It is particularly serviceable in removing dropsical fluid by way of the kidneys, when the dropsy is due to bad circulation from some defect of the heart. It is useless to discuss here the kind of cases of heart disease in which it is useful, for in certain cases of heart disease, where the valves of the aorta (p. 239) are affected, it is held to be injurious. Whether it is likely to be useful or not is, therefore, a question for a skilled physician. It is in cases of weak irregular heart, unaccompanied by valve disease, specially in those well advanced in years, that its most marked effects are seen. One would begin with a small dose, 5 drops or so, thrice daily, and work slowly up, adding an extra drop or two daily till a steadying effect was produced, not going beyond 20 drops without great caution. In such cases sleeplessness is a very common symptom, and a marked degree of restlessness. This is due to the defective circulation, and often one of the first signs of marked improvement following the use of the drug is the passing off of the restlessness and sleeplessness, when the patient falls into a sound quiet sleep. The drug has a cumulative action, that is, it is not rapidly expelled from the body, and small doses continued for some time may suddenly lead to the production of unpleasant symptoms, sickness or faintness. In such cases the drug should be much diminished in dose. It must further be noticed that patients getting full doses of the drug should lie in bed; getting up on to their feet is apt to induce an attack of faintness.

Squills.—The squill is a pear-shaped bulb (*Urginea Scilla*) belonging to the lily order, and found growing along the shores of the Mediterranean. The bulb is sliced and dried for medicinal purposes.

Its preparations are:—

	DOSE.
Vinegar of Squill	15 to 40 drops.
Syrup of Squill (1 oz. vinegar of squill, 2 oz. sugar)	½ ,, 1 tea-spoonful.
Oxymel of Squill (5 oz. vinegar, 8 oz. honey)	½ ,, 1 ,,
Tincture of Squill	15 ,, 30 drops.
Compound Squill Pill	5 ,, 10 grains.

Actions and Use.—Squill acts upon the heart in a manner similar to digitalis. It is even more irritating to the stomach and bowels. Its common popular use is for cough, for which it is constantly given without judgment, in the form of syrup. It stimulates the lining membrane of the air-tubes, and increases the expulsion of phlegm and other matter. It is, therefore, useful in chronic bronchitis when the excretion is profuse, but not when active inflammation is going on. Its constant use, therefore, specially for children, ought not to be encouraged. It acts like digitalis upon the kidney, increasing the amount of urine.

Lily of the Valley (*Convallaria majalis*) resembles digitalis and squill in action on the heart and kidneys, and in its irritating effect upon the stomach and bowels.

Its preparations are the watery extract, of which the dose is 2 to 8 grains, and convallamarin, the active principle, of which the dose is ½ to 2 grains.

Strophanthus hispidus (*Kombé*) is one of the most recently introduced drugs, its employment being recommended, in certain cases of heart disease, by Professor Fraser, of Edinburgh, in 1887. The seeds are employed in Africa to yield an arrow-poison. Its chief preparation is:

Tincture of Strophanthus.......Dose, 2 to 5 drops.

Its action much resembles that of digitalis, being that of a tonic to the heart-muscle. It strengthens the beat of the heart and slows its frequency, the slowing action being sometimes very marked. It is used in certain cases of heart disease, but its action has not yet been sufficiently studied to enable one to say exactly under what circumstances it is useful. One advantage it seems to possess over digitalis is its less tendency to create sickness and irritation of the bowels, but in one case in which the author administered it in very large doses, severe cutting pains in the bowels occurred, apparently due to its action on the muscular wall of the bowel.

Heart Sedatives.

Drugs which soothe the heart, which diminish the force and frequency of its beat, are heart

sedatives. In one way they act by weakening the heart's action, by depressing it. Sometimes they are employed for such purposes, for example, in cases of severe inflammation or high fever in strong persons. But they are not, just on that account, remedies to be used except by those whose knowledge enables them to form a correct judgment of their suitability, and whose experience qualifies them to watch that their effects do not pass beyond the production of the desired result, for they can easily produce a dangerous weakening of the heart. It ought further to be observed that often an irritable, palpitating, heart, which the inexperienced would imagine needed soothing remedies, requires really tonic treatment. In some such cases the heart is irritable and irregular, and the patient feels it thump and bound unpleasantly against the chest wall, because it is weak, because it needs strengthening, and then anything which would depress it would act more injuriously, whereas anything which would exert a toning action upon it, such as digitalis, would speedily relieve the symptoms. What has been said ought to be sufficient by way of caution against the use of such drugs except under medical advice, and we shall consider only one of this class, but that one which is most frequently employed, namely, aconite.

Aconite.—The leaves, flowering tops and root of the *Aconitum Napellus*, or monkshood (see Plate XIII.), are employed in medicine, the two first to yield an extract, the last to yield a tincture, the preparation commonly employed.

Tincture of Aconite ....Dose, 5 to 15 drops.
Liniment of Aconite.

The active principle of aconite, aconitia, a most active poison, is employed for the preparation of an ointment.

Actions and Uses.—If aconite be applied to the skin it causes a tingling sensation, followed by numbness. If it be taken into the mouth and swallowed, a similar feeling is experienced in the tongue and gullet, and a sensation of warmth in the stomach, in large doses pain and sickness also. In large doses, after the drug has entered the blood and been distributed throughout the body, the same tingling is experienced in all parts of the body, the most sensitive parts being affected first, tongue and lips, then finger tips, face, breast, and the back last of all. This effect is due to the fact that the drug acts on the ends of the nerves of sensation, and reduces their sensibility. It is, therefore, used as a liniment or as an ointment for painful parts (Note: *where the skin is not broken*), such as in neuralgia, rheumatism, &c. The liniment may readily be used for such a purpose, never the ointment, unless ordered by a medical man, and it must be remembered that some of the drug may gain access to the circulation by the skin and produce its effects upon the body in general. When taken internally, besides the effects already spoken of, aconite specially acts upon the heart and upon the breathing. The heart is very quickly influenced, and usually by counting the pulse this can be noticed in a comparatively few minutes by the diminished pulse-rate. In excessive doses the heart becomes weak and irregular. The breathing is also slowed, made feeble and shallow, and in poisonous doses breathing is usually stopped before the heart ceases to beat. In excessive doses, also, great muscular prostration is experienced along with the tingling and numbness already mentioned, but the mental faculties are unaffected. In doses appropriate for remedial purposes the action is, then, to reduce the force and frequency of the pulse, to diminish the rate of breathing, and to lessen the sensibility of the skin, and also the skin becomes flushed and moist. It is, therefore, in acute inflammatory diseases, and in high fever, that its action would be beneficial. As a matter of fact it is mainly employed in such limited inflammations as quinsy, that is, inflammation of the tonsils and the throat, inflammation of the lungs (pneumonia) in strong and otherwise healthy persons, and in pleurisy. In such diseases its effect upon the heart very considerably abates the inflammatory symptoms, and in scarlet fever and other fevers, where the high degree of heat threatens mischief, it is also employed. In inflammation of the tonsils, inflammatory sore throat, where the pain and swelling of the throat are great, the fever high, the pulse very quick and bounding, and the face flushed, it commonly produces marked relief. As this disorder is not uncommon, and as the drug can be employed for it in a particular manner, which renders its use free from risk, it may be well to state how it should be employed, for the benefit of any who may be far from medical advice. The person should first make a note of the sufferer's pulse, noting number of beats per minute (see p. 11), regularity, &c. A single drop (*1 drop*) of tincture of aconite is then given in a little water, and this dose is repeated every quarter or half hour, according to the urgency of the case, the rate of pulse being noted before each dose, until a considerable slowing of the pulse is perceived,

DEADLY NIGHTSHADE or DWALE. (DEADLY DWALE.)
BLACK-CHERRY NIGHTSHADE.
(Atropa Belladonna)

FLY BLOWN MUSHROOM. FLY AMANITA.
(Agaricus Muscarius or Amanita Muscaria)

STRONG SCENTED or POISONOUS LETTUCE.
(Lactuca Virosa)

after which a drop every hour or every two hours may be sufficient to maintain the effect. Thus, suppose the pulse beating at first 120 times a minute or more, suppose a drop given every quarter of an hour, and in, let us say, three hours, the pulse-rate reduced to 100. Then the drug would be given at intervals of an hour, and if, in another hour, the pulse was still falling, say had fallen to 90, the dose would be stopped. If, after an hour or two, the pulse began to increase in frequency again, the drop every hour would be resumed, and if that did not control it, the drop every half-hour, to be again stopped when necessary.

From its effect on the sensory nerves, aconite is sometimes given internally in painful diseases like rheumatism, gout, lumbago, but is not to be recommended; and there are other drugs more certain to relieve, such as salicine, antipyrin, quinine, &c., which do not require so much caution in their use.

DRUGS WHICH ACT ON THE BLOOD-VESSELS.

The two actions which, for popular purposes, are all that it is desirable to consider under this head, are that by which blood-vessels may be caused to contract, so that less blood flows through them, and that by which they may be caused to dilate, so that more blood may flow through them. The former action one desires to secure locally, when a part of the body is in a state of active inflammation, and would be most readily secured by local cold, the application of cold-water cloths, of iced cloths, of evaporating lotions, and so on. It is the result one seeks also in order to control bleeding, and when the bleeding is external, cold, &c., is applied for that purpose (see under Accidents and Emergencies). On the other hand blood-vessels may be caused to dilate by the use of heat, hot poultices and fomentations, by the external use of mustard, which brings the blood to the skin by paralysing the walls of the vessels of the skin for a time, and so enabling the pressure of blood within them to widen them to their utmost limits. This action is performed when one desires to bring the blood to the skin and so to relieve deeper organs. Thus a mustard poultice over the chest brings the blood to the skin, and tends to relieve any deep-seated inflammation, and a mustard foot-bath is a very efficient way of bringing blood down from the head. There are several drugs, which taken into the system, act upon the blood-vessels in this way, causing their contraction and a diminished flow of blood through them, or causing their relaxation and a more easy flow.

Drugs which Contract the Blood-vessels.

Ergot of Rye is one of the **vascular astringents,** drugs which contract the blood-vessels. It is obtained from a fungus growing upon the common rye (see p. 565).

Its preparations are:—

	DOSE.
Liquid Extract of Ergot	15 to 30 drops.
Infusion of Ergot	1 ,, 2 fluid ounces.
Tincture of Ergot	15 ,, 60 drops.

Action and Use.—One of the chief actions of this drug is to cause contraction of the smaller arteries, and it is therefore in very common use to control internal bleeding, as from the lungs, womb, bladder, bowels, &c. It has also a special action upon the pregnant womb, which makes it a most valuable drug in bleeding after childbirth and other conditions. **Ergotism** is the term applied to a set of symptoms arising from poisonous doses, or protracted use, and has been seen frequently in certain parts of Germany where rye is the common article of food, and the diseased plant has been made use of. The symptoms are gangrene of the extremities, and nervous symptoms, such as a sensation as of insects crawling over the limbs, loss of sensation in hands and feet, flying pains, and convulsions.

Ergotin is a purified extract of ergot, given in pill form, the dose being 2 to 5 grains.

Ergotinin, the active principle of ergot, is employed to inject, under the skin, when one wishes to secure rapid action of the drug. The dose is $\frac{1}{300}$th grain.

Witch-hazel (*Hamamelis virginica*) or **Winter-bloom** is a shrub, 6 to 8 feet high, growing in damp woods and thickets in Canada and the United States of America. The flowers are collected in autumn. A liquid extract is prepared. In America a preparation known as **Pond's Extract** is derived from witch-hazel. It is clear, like water, and with a peculiar fragrance. A similar preparation is known in Britain as **Hazeline.** Of the two latter a tea-spoonful dose may be taken internally at intervals of 2 or 3 hours, and of a tincture, also prepared, the dose is 2 to 5 drops.

Uses.—Witch-hazel is used both internally and externally for bleeding. In bleeding from lungs, stomach, bowels, kidneys, and bladder any of the preparations named may be taken in the doses noted. For external bleeding, for cuts, and bruises it is applied as a lotion. For bleeding piles it may be used as a lotion, or a tea-

spoonful of the tincture in 3 ounces of cold water may be used as an injection. A dry extract is also prepared, which may be used as an ointment or made into a suppository. A tea-spoonful of the tincture, of Pond's extract, or of hazeline, mixed with a table-spoonful of warm water, is a useful lotion for inflamed eyelids, and to discharging sores it is also a valuable application.

Lead is largely employed to contract blood-vessels and control bleeding.

Its chief preparations are:

Acetate of Lead (Sugar of Lead)	Dose 1 to 4 grains in pill.	
Lead and Opium Pill	,, 3 to 5 grains.	
Solution of Sub-acetate of Lead (Goulard Extract)		used for external application.
Dilute Solution of Sub-acetate of Lead (Goulard Water)		used for external application.

Uses.—Lead is extensively employed as a wash for ulcers, sores, and inflamed surfaces, itching diseases of the skin, irritable piles, &c., relieving pain and itching and promoting healing. The highly inflamed and irritable sores are those suitable for this treatment, and the Goulard water is the preparation employed, diluted with several parts of water. The acetate of lead is a common ingredient in eye-washes, but ought not to be used without advice, as in some kinds of eye inflammation it is deposited as a white crust on the front of the eyeball. When given internally lead has a strong astringent action on the lining membrane of the stomach and bowels, and is used for bleeding from these surfaces and for diarrhœa and dysentery. The lead and opium pill is thus given, but ought not to be used without advice. Absorbed into the blood, it passes into distant organs and controls bleeding from the lungs, kidneys, and womb.

Lead-poisoning is frequent among painters, those engaged in colour-grinding, plumbing, type-founding, &c. The lead is derived from particles adhering to the hands and swallowed with food, from dust getting into the mouth, and inhaled from the clothes, &c. All workers among lead ought, therefore, to wash their hands and use a tooth-brush to the teeth before taking food, should not take food in the room where the work is going on, and ought to change their clothing as soon as work is over. A flannel respirator over the mouth and nose is, in some cases, needed, to prevent inhalation of the dust. Chronic lead-poisoning also arises from drinking waters contaminated with the metal. The symptoms of lead-poisoning are a blue line along the gums, colic in the bowel, usually accompanied by loss of appetite, cramps in the calves of the legs, and paralysis of certain muscles. Those of the wrist are chiefly affected, producing the characteristic "wrist drop," due to an inability to raise the wrist on the forearm. Headache and other brain symptoms also occur, disease of the kidneys also, and disease of the nerve of the eye, leading to dimness of vision and perhaps blindness. The treatment of lead-poisoning consists in removing the person from the source of the lead, and in giving some medicine which will aid in removing the lead from the body. For this purpose iodide of potassium is the drug used, in 5-grain doses, dissolved in water, given several times a day. Workers among lead are advised to take an occasional dose of Epsom-salts acidulated with a few drops of sulphuric acid as a preventative.

Drugs which Relax the Blood-vessels.

We all know that there are many means of relaxing the smaller blood-vessels of a part of the body and thus bringing a more copious supply of blood to the part. Thus putting the feet or hands in hot water brings the blood rapidly to the skin of these parts, and this can be effected elsewhere by the use of hot-water pads, hot poultices, and the like. Irritating substances, like mustard, have a similar effect. A mustard poultice reddens the skin by dilating the blood-vessels, and mustard, cayenne, camphor taken by the mouth, have a similar effect on the walls of the digestive canal. Such methods are often employed to withdraw blood from one part of the body threatened with or suffering from inflammation. Thus the purpose of applying a mustard poultice or a fly-blister to the walls of the chest in bronchitis or inflammation of the lung is to draw the blood from the deeper parts to the skin and so relieve the inflammation. The usual object of taking substances by the mouth which shall redden the walls of the stomach and bowels is to stimulate them to greater activity in the work of digestion, by bringing a more copious supply of blood for the production of the digestive fluids. Then there are many remedies which act upon special organs, exciting their blood supply and increasing their activity. For example, solution of acetate of ammonia relaxes the blood-vessels of the skin, and increases sweating. Alcohol has a pronounced effect of this kind. It dilates the surface blood-vessels all over the body, and thus induces a feeling of warmth. As a matter of fact, however, instead of causing an actual increase of heat to the body, it occasions a positive loss of heat, from the increased loss from

the surface (see p. 673). There are one or two drugs which very quickly dilate the blood-vessels all over the body; the chief of these is nitrite of amyl.

Nitrite of Amyl. This is prepared from amylic alcohol and nitric acid. It is an ethereal liquid of a yellowish colour, a pungent aromatic taste, and peculiar fruit-like odour. It was introduced as an anæsthetic by Dr. Richardson in 1863. When 2 or 3 drops are placed on a handkerchief and inhaled, after a momentary tickling sensation at the throat causing cough, the face begins to flush, the pulse becomes faster and fuller, and the breathing is much quickened. In about a minute the vessels of the head are felt to throb, there is a feeling of fulness in the head and a sensation of giddiness, especially if the person sits up. If a larger quantity be inhaled, the breathing becomes laboured, and the face becomes crimson, and later of a darker hue, and the sight becomes dimmed. These effects are due to the dilatation of the smaller arteries permitting a fuller and freer flow of blood to the surface, to quickening of the heart, and to an interference with the exchanges between the blood and the air. The drug is employed to dilate the smaller arteries in order to relieve spasm in angina pectoris (p. 243). The peculiar and intense pain of this disease seems to be due to some spasmodic condition of the smaller arteries, by which they become contracted in calibre, the pressure of blood within them consequently rising. It was because experiment had shown that nitrite of amyl had the power of producing an exactly contrary effect, dilating the small arteries and lowering the blood pressure, that it came to be tried in this disease. Results obtained from it have been just those which were anticipated, and it has become one of the chief drugs relied on to relieve the spasm. In some cases it has failed, and it has been suggested, that the failure may have been due to perfectly fresh nitrite not having been employed. It may be, that is to say, that the drug loses its power with keeping.

Pure asthma, nervous asthma, is also a spasmodic condition, in which the smaller bronchial tubes are greatly contracted. For this condition also nitrite of amyl is employed, and often with relief. It is for these purposes inhaled from a handkerchief in doses of from 2 to 5 drops, and the person should be lying down, lest faintness occur, and be attended by some one. It should not be given to full-blooded people, in whom there is any risk of apoplexy. It has been tried for epilepsy, sick headache (migraine), sea-sickness, but without much success.

Nitro-glycerine is employed in medicine in doses of from $\frac{1}{200}$ to $\frac{1}{50}$ grain, to produce effects similar to those due to nitrite of amyl.

Spirit of Nitro-glycerine, ... Dose, ½ to 10 drops.
(1 grain of nitro-glycerine in 100 drops of rectified spirit.)
Tablets of Nitro-glycerine, .. ,, 1 or 2 tablets.
(Tablets of chocolate weighing 2½ grains, and containing $\frac{1}{100}$ grain pure nitro-glycerine. Other strengths are also prepared.)

Nitro-glycerine acts like nitrite of amyl, and has been used for angina pectoris, epilepsy, neuralgia, spasmodic asthma, puerperal convulsions, neuralgia of stomach, and many other diseases. Its usefulness in many is dubious; in many persons the smallest dose produces intense headache; and in any case it is a drug of such power that a physician would use it only with great caution. In poisonous doses it produces great depression, the pulse and breathing become very much quickened, paralysis of motion and of sensation is produced; and if death results, it is by arrest of the breathing.

SECTION III.—DRUGS WHICH ACT ON THE STOMACH, BOWELS, LIVER, AND DIGESTIVE SYSTEM GENERALLY.

Drugs which Act on the Stomach.

Stimulants to the Stomach—Tonics:

Bitter Tonics—Angostura Bark, Calumba Root, Cascarilla Bark,
Chamomile Flowers, Chiretta, Gentian Root, Hops, Peruvian Bark, and Quinine,
Quassia Chips, Serpentary,
Their Preparations and Doses;
Acid Tonics—Dilute Hydrochloric, Nitric, and Sulphuric Acids;
The Uses of Acid Tonics;
Alkaline Tonics—Soda and Potash, Ammonia, Magnesia, and Lime;
The Uses of Alkaline Tonics.

Artificial Digestive Agents:

Pepsin—Its Preparation and Uses;
Pancreatin and Liquor Pancreaticus;
Papain—Its Ferment Action, and its Use in Diphtheria;
Ingluvin and Lactopeptin.

Remedies for Flatulence of Stomach:

Anise, Assafœtida, Camphor, Cayenne, Dill, Ginger, Peppermint, &c.

Emetics:

Warm Water, Mustard and Water, Infusion of Chamomile Flowers, and Carbonate of Ammonia as Emetics;
Sulphate and Acetate of Zinc, Copper, and Alum as Emetics;
Ipecacuanha—Its Preparations, Doses, and Uses;
Antimony (Tartar Emetic);
Apomorphia.

Remedies which Soothe the Stomach:

Ice as a Sedative to the Stomach;
Bismuth—Its Preparations and Uses;
Dilute Hydrocyanic Acid;
Belladonna, Opium, Oxalate of Cerium, Chloroform, Ether, Cocaine, &c., as Sedatives to the Stomach.

Drugs which Act on the Bowels and Liver.

Remedies for Constipation:

Laxatives—Fruits, &c.
Castor-oil; Senna and its Preparations;
Sulphur; Tamarind; Tamar Indien and Tamarind Whey;
Buckthorn, Dandelion (Taraxacum), *Glycerine, Olive-oil,* &c.
Simple Purgatives—
Rhubarb and Aloes;
Stronger Purgatives—Cathartics—
Colocynth, Gregory's Pill;
Scammony and Jalap.
Drastic Purgatives—
Elaterium, Croton-oil, and Gamboge.
Saline Purgatives—
Epsom-salts, Seidlitz-powders, Fruit-salts;
Cream of Tartar, Rochelle-salts, Glauber's-salts.
Purgatives which Increase the Flow of Bile—
Podophyllin; Euonymin; Iridin;
Hydrastin; Leptandrin; Juglandin;
Phytolaccin.

Remarks on the Use of Purgatives.

Remedies for Diarrhœa:

The Use of Opium, Castor-oil, Magnesia, Chalk, and Soda in Diarrhœa;
Tannic and Gallic Acids;
Catechu; Kino; and Rhatany;
Red Gum; Bael Fruit; Logwood; Oak and Elm Bark;
Alum, Iron, Copper, Zinc, and Silver Preparations.

Remarks on the Use of Remedies for Diarrhœa.

Remedies for Flatulence of the Bowel.

Remedies for Intestinal Worms: Anthelmintics:

Remedies for Tape-worm—Male-fern and Areca-nut;
Kamala and Kousso;
Pomegranate Root Bark and Turpentine.

Remedies for Round-worms—Santonica and Santonin;
Spigelia Root.

Remedies for Thread-worms—
Injections of Salt, Quassia, &c.

Injections for the Bowels: Enemata:

Nutritive and Stimulant Enemata;
Opening and Purgative Enemata—Salt, Soap, Castor-oil, Aloes, Turpentine, &c.;
Opium and Astringent Enemata—Enemata for Pain and Diarrhœa;
Enema for Piles.

Remedies which Act upon the Liver:

Stimulants to the Liver—
Nitro-hydrochloric Acid; Chloride of Ammonium.

Drugs which Depress the Liver—
Quinine, Opium, &c.

In this section we must consider the action of remedies upon several organs, stomach, small and large intestine, and liver, all of which are concerned in the digestive process. It is really impossible completely to limit the action of a medicine to one of these organs, and the effect which a medicine produces will most commonly be the combined result of its action upon several parts of the digestive canal. If, therefore, we consider the remedies which act upon the digestive apparatus under several subdivisions, such as those which act on the stomach, those which act on the bowel, those which act on the liver, and so on, it must be understood that the arrangement is mainly for convenience, and that the same remedy may be entitled to be included in each division.

DRUGS WHICH ACT ON THE STOMACH.

That the stomach may be acted upon in a variety of ways in order to influence the manner in which it performs its work in the digestion of the food will be plain to everyone who studies that part of Section IV. A. of Part I. which deals with the structure of the stomach (p. 138) and digestion in the stomach (p. 143). There it has been pointed out that digestion is carried on by the agency of the gastric juice, manufactured by the glands of the stomach from blood flowing in the vessels of the mucous membrane, aided by heat and the movements of the stomach walls. The quantity of gastric juice manufactured depends on the activity of the circulation, and it has been mentioned (p. 139) that the mere contact of the food with the wall of the stomach excites increased blood supply to the glands and increased flow of the digestive fluid. It has also been explained that the chief ingredients of the gastric juice are hydrochloric acid and pepsin, and that the whole process is under the influence of the nervous system. It is clear, then, that drugs may be given (1) which shall slightly irritate the mucous membrane of the stomach and determine a much larger flow of blood and, therefore, increased production of gastric juice; or (2) which shall also excite more marked movements of the muscular walls. But sometimes gastric juice in sufficient quantity may be produced but it is not sufficiently active, because of being deficient in acid or in pepsin, owing, it may be, to a state of general debility. In such a case (3) the deficient quantity of acid or pepsin may be made up by some being taken as a medicine. In all these cases the object is to stimulate the stomach, to rouse it to do its work better, more quickly, or more completely. These drugs will, therefore, be rightly called **stomach stimulants or tonics.** On the other hand, the lining membrane of the stomach may be unduly irritable, when the smallest quantity of food is apt to be rejected, as it often is in catarrhal states. Under these circumstances medicines which will soothe the stomach and diminish the irritability are desired, and these are called **stomach sedatives.** Another class of remedies are useful when, owing to some form of indigestion, the contents of the stomach become too acid, leading to heart-burn and acidity, or when the stomach is distended with wind and pained by the irregular spasm it induces. To the former remedies the term **antacids** is applied, and to the latter **carminatives** (from Latin *carmen*, a song, a charm), because they act quickly in relieving spasm as by a charm. Finally, there is a class of drugs employed to excite the stomach to eject its contents by vomiting—**emetics.** It is under these divisions that we shall consider the drugs which act on the stomach.

Stimulants to the Stomach: Tonics.

Bitter Tonics.

Bitter tonics are among the simplest of the drugs which stimulate digestion in the stomach. This they appear to do by stimulating an increased flow of gastric juice by their chemical action on the stomach walls, reddening the surface, bringing an increased supply of blood, exciting the nerves of the stomach, and thus improving the appetite and increasing the relish for food, as well as actually aiding the digestive process.

The chief bitter tonics are:

- Angostura or Cusparia.
- Calumba.
- Cascarilla.
- Chamomile.
- Chiretta.
- Gentian.
- Hops.
- Peruvian Bark and Quinine.
- Quassia.
- Serpentary.

The common form in which these substances are employed is that of infusion, and the usual dose is from 1 to 2 ounces.

It must not be forgotten that the action of these substances is stimulating, or to put it in other words, mildly irritating. If too much of the drug be used, or in too strong a form, the irritation may become excessive, and produce effects exactly the opposite of those desired, loss of appetite, diminished digestive power, and even sickness and vomiting. A very good example of this is afforded by the infusion of chamomile flowers, of which a dose of from 1 to 2 or even 3 ounces is a stomach stimulant, while 5 to 10 ounces act as an emetic. And here we have an illustration of the complex problem one often meets with in the treatment of disease—the indigestion of which one person complains may arise from an undue irritability of the mucous membrane of the stomach. If he seeks relief by the use of a bitter tonic, he will probably be surprised to find that, instead of aiding his digestion and improving his appetite, as he has been informed is its usual effect, the bitter has increased his disagreeable sensations. In short, the stomach already too irritable, is made still more so by the stimulating action of the medicine, and what he requires is a soothing remedy. One guide to the nature of the stomach condition is the appearance of the tongue, a very red tongue with prominent papillæ on its surface indicating an irritable stomach, while a flabby whitish tongue indicates the reverse.

Angostura or **Cusparia Bark** is the dried bark of a tree of tropical South America, the *Galipea Cusparia.* To make the infusion take 1 ounce of the bark in coarse powder, and add 20 ounces distilled water, heated to 120°; infuse two hours and then strain. It is used as a tonic in cases of weak digestion, and in recovery from acute diseases; and in warm climates it is found useful in intermittent fevers and dysentery. It may be noted that false angostura bark is the bark of the *Strychnos nux vomica,* which is poisonous, and the substitution of which for the pure bark has led to fatal accidents. The two may be distinguished from one another by the fact that the false bark when touched with nitric acid on the inner surface becomes blood-red, from the presence of a substance called brucia; the true bark does not.

Dose of infusion—1 to 2 ounces.

Calumba Root. The root of the *Jateorhiza Calumba,* or *Cocculus palmatus,* indigenous to the forests of Mozambique, and abundant along the lower Zambesi River. The infusion is made with 1 ounce coarsely-powdered root steeped for one hour in 20 ounces *cold* distilled water, and then strained. A tincture is also made which keeps, while the infusion does not.

Dose of infusion 1 to 2 ounces (2 to 4 table-spoonfuls).
,, tincture ½ to 2 tea-spoonfuls.

Cascarilla Bark, or sweet-wood bark, the bark of *Croton Eleuteria,* comes from the Bahamas. Of it also an infusion and a tincture are prepared, the former by pouring 10 ounces boiling distilled water over 1 ounce of the coarsely-powdered bark, and straining after an hour's infusion. The infusion does not keep well.

Dose of infusion 1 to 2 ounces, of tincture ½ to 1 tea-spoonful.

It is used not only as a tonic to the stomach, but also as an aid to the expulsion of phlegm from the air-passages in chronic bronchitis.

Chamomile Flowers are the dried flower-heads of the common chamomile, *Anthemis nobilis,* cultivated for the purpose. The infusion is made with ½ ounce of the flowers and 10 ounces of boiling water. It is strained after a quarter of an hour's infusion.

It is used as a tonic for indigestion with flatulence, and also for summer diarrhœa of children, and for sick headache; and is a useful lotion, when diluted with 1 or 2 table-spoonfuls of warm water, for inflamed eyelids. An oil may be distilled from the flowers.

Dose: 1 to 3 ounces as a tonic, 5 to 10 ounces as an emetic.

Chiretta is the entire plant of the *Ophelia Chirata*, collected in Northern India. The infusion is yielded by 1 ounce of the dried plant, cut small, and 40 ounces water heated to 120°, and is strained after half an hour. It is a pure bitter tonic, and has properties similar to gentian; its dose being the same.

Gentian Root is the dried root of the *Gentiana lutea*, found in mountainous districts of Central and Southern Europe, the Alps, Apennines, &c. From it are obtained a compound infusion and a compound tincture. The former is made with 1 ounce of the root, 1 ounce of bitter orange peel, 2 ounces of fresh lemon peel, and 80 ounces boiling water, infused one hour, and then strained. It is a very generally used tonic, a pure bitter, and also useful as a general tonic. An extract is employed in pill.

Dose: of infusion 1 to 2 ounces, of tincture ½ to 1 tea-spoonful.

Hops. The dried flower-spike of the female plant of the *Humulus Lupulus*, cultivated largely in England, is used to yield an infusion and a tincture, and also an extract. Of hops 1 ounce is used to 20 ounces of boiling water, and allowed to infuse for two hours; it is then strained. Hops contain a bitter principle—lupuline—and a volatile oil. They are used to impart the bitterness to beer. Besides being useful as a tonic to the stomach, hops have a soothing effect on the nervous system, tending to produce sleep. They are sometimes used in the form of a poultice or fomentation for painful swellings.

Dose: of infusion 1 to 2 ounces, of tincture ½ to 2 tea-spoonfuls.

Quassia Wood is the wood of *Picrœna excelsa*, growing in Jamaica. It is obtained in the form of chips and raspings. An infusion (60 grains of the chips infused for half an hour in 10 ounces distilled water and strained) and a tincture are its chief preparations. It contains a bitter principle, quassiin, but no tannin, and is therefore a simple bitter without astringence. Too large a dose is irritating to the stomach and causes vomiting. This wood is often made into a cup which imparts its bitterness to water allowed to remain in it for a short time. An infusion is used as an injection into the bowel to destroy thread-worms. The dose is the same as of gentian.

Serpentary—the underground stem of the *Aristolochia Serpentaria*, belonging to the southern part of North America. From it an infusion and tincture are prepared. The former is made with 1 ounce of bruised serpentary infused for two hours in 40 ounces of boiling water and strained. It is used in the production of compound tincture of cinchona (p. 820). It not only acts as a tonic to the stomach, but also stimulates the action of the kidney and skin, and is therefore employed in chronic rheumatism, and in low fevers.

Dose: of infusion 1 to 2 ounces, of tincture ½ to 1 tea-spoonful.

Peruvian Bark and Quinine have already been considered on p. 820.

Acid Tonics.

The acids chiefly used as stimulants to the stomach are:—

Dilute Hydrochloric Acid......	Dose	10	to	30	drops.
Dilute Nitric Acid	,,	10	,,	30	,,
Dilute Nitro-hydrochloric Acid	,,	5	,,	20	,,
Dilute Sulphuric Acid...........	,,	5	,,	30	,,
Dilute Phosphoric Acid.........	,,	20	,,	30	,,

The Uses of Acids. There is an obvious purpose in using acid to assist digestion. We have seen (p. 143) that the gastric juice is acid, that digestion in the stomach cannot occur unless the fluid be acid, and that the acid present is hydrochloric. It is easy to argue, therefore, that in cases of indigestion, the administration specially of hydrochloric acid will be a great aid, and in many cases this is so. For example, a person who, immediately after food, suffers from a feeling of weight in the stomach, which persists for a long time, and has hardly passed away before the next meal is due, or who after food is afflicted with a feeling of sickness, accompanied by the rising into the mouth of a quantity of a tasteless watery fluid (water-brash, see p. 181), perhaps ending in the vomiting up of a quantity of the unaltered food, will probably find much relief from taking 10 drops or so of hydrochloric acid in half a wine-glassful of water *after meals*. But this fact of the acidity of the natural stomach juice is not the only one which determines the employment of acids in stomach derangements. It is found that glands which produce an acid juice are excited to their work, or stimulated, by substances of an opposite character, that is by alkalies such as soda, potash, &c., and that their activity is diminished by the application of acid substances. On the other hand glands which produce an alkaline fluid are stimulated by acids, but have their activity lessened by soda or potash and such substances. Thus the fluid poured into the mouth from the salivary glands is alkaline, and

we know what a rush of fluid comes to the mouth when an acid substance is tasted, which is not experienced when some soda in water is taken. Thus a few drops of acid in water will promote the flow of the saliva into the mouth, but when it reaches the stomach will diminish the flow of the acid gastric juice. If acids are taken to assist digestion it must not be before food, for then they would only diminish the flow of gastric juice, but it ought to be after food, when the gastric juice has already been mixed with the food and one wishes to increase its acid properties. On the other hand if acidity and heartburn come on very soon after a meal, this implies that too much acid gastric juice is poured into the stomach. In such a case by taking acid *before a meal*, a person would hope to *lessen* the quantity of juice secreted, and so remedy the acid indigestion. But any one who is troubled with acidity and takes some drops of acid after food can expect only to increase his affliction. Exactly the reverse holds true with reference to alkalies, that is soda and potash. Soda or potash taken *immediately before a meal* excites by its antagonism a flow of the acid stomach juice, and is therefore a powerful remedy for indigestion due to deficiency of that digestive fluid. They should be taken *after a meal* only to correct acidity and heartburn, when they no longer encourage the flow of gastric juice, but neutralize some of the excess of acid. As a general rule, then, we may lay it down that to stimulate the stomach to the digestive process acid tonics should be taken *after meals*, and that a like purpose is served by taking alkaline (soda, potash) remedies *immediately before meals.* The best acid to use for this purpose is dilute hydrochloric acid. A similar explanation is offered for the value of acid drinks in relieving thirst, and moistening the mouth in fevers. They so stimulate the salivary glands and the glands of the mouth that a copious watery secretion results which moistens the mouth and throat. For this purpose a preparation of sulphuric acid, aromatic sulphuric acid, is very useful, a few drops in a glass of water. Citric acid, prepared from the juice of the lemon or lime, is also valuable, 17 grains in an ounce of water making a solution resembling lemon juice.

Besides the effects in the stomach that have been noted, acids produce a further action when they reach the small intestine, explained in a similar way. The bile is poured into the small bowel a few inches below the opening of the stomach, and the pancreatic juice in its neighbourhood. Both these juices are alkaline, and thus when the acid contents of the stomach pass over the openings of the channels from these organs, the result of the irritation is a copious flow of the two juices. Acids are thus frequently given for the avowed purpose of stimulating the liver, the dilute hydrochloric and dilute nitro-hydrochloric acids, in 10-drop doses, being specially used for this purpose. In chronic cases of sluggish liver they are very serviceable. They are also used as general tonics, phosphoric acid being employed in cases of nervous exhaustion.

It must not be forgotten that while the use of dilute acid in indigestion may afford great relief in appropriate cases, it must not be too long continued. Their employment for a prolonged period continuously defeats the end aimed at. Their beneficial effects become lessened because, by and by, they tend to induce catarrh of the stomach and bowels. The proper plan, therefore, is to employ them for a week or two, then to stop and substitute an alkaline tonic, taken before food (see below), for a week or two, and then, if need be, to return to them again for another brief period. This tendency with prolonged use to set up catarrh, and therefore interfere with digestion, is alleged as the reason for the effect of vinegar in reducing fatness, and this is not a purpose for which they ought to be used. The scientific method of reducing fat is fully explained on p. 625.

For many other conditions of the stomach and bowels, besides that of simple indigestion, are acids administered. Their constringing action on the lining membrane makes them useful in bleeding from the stomach or bowels and in diarrhœa, dilute sulphuric acid being the one specially used. Indeed sulphuric acid is employed for controlling bleeding in other organs, the lungs and womb, for example. To reach these organs it must pass into the blood, and it is not conveyed in the form of acid but in chemical combination as sulphates, and how it in this condition controls bleeding is unknown. It has also a marked effect in relieving profuse sweating. The organic acids, citric, tartaric, and acetic, chiefly the former, are employed in rheumatism, but they never reach the tissues in that shape, but in the form of citrates of potash, &c. &c., when they have lost their acid properties.

It will complete our view of the action of acids, and avoid the necessity of anything more than a mere reference in other sections, if we note here some of the local actions of acids. In their undiluted form they are powerful irritants, and some of them exert powerfully destructive

actions on the tissues. They are occasionally used for such purposes. Strong nitric acid is employed to destroy foul sores, and to restore a healthy action to certain ulcers. Applied immediately to a part bitten by some poisonous animal, it prevents the possibility of absorption of the poison into the system. Acetic acid and glacial acetic acid are applied to warts. Such applications must be made with the greatest care, the part being simply lightly touched with a glass rod dipped in the acid and immediately thereafter bathed with cold water, and special care must be taken to prevent the acid running on to the sound skin. Dilute acid is used with which to sponge the skin in fever, producing a grateful cooling effect, and is similarly used to limit excessive sweating. Very dilute solutions of acetic and sulphuric acids are the best for this purpose. A tea-spoonful of *dilute* nitric acid to a pint of water used as a lotion for swollen and bleeding piles affords marked relief.

Alkaline Tonics and Remedies for Acidity: Antacids (Soda, Potash, &c.).

The alkaline medicines used as tonics are:—

Compounds of soda,
,, ,, potash,
,, ,, ammonia,
,, ,, magnesia,
,, ,, lime.

Potash and soda have already been discussed on p. 818 and 819, the chief compounds employed being the bicarbonates of potash and soda and the solution of potash. We shall note a few of the preparations of ammonia, magnesia, and lime, and then consider the effects of alkaline tonics as a group, as we have done with acids.

Ammonia is, when pure, a colourless gas with a very pungent odour. The ordinary liquor ammonia, or hartshorn, is a solution of the gas in water. It was called hartshorn because it was readily obtained from animal substances, such as horn, hoof, &c. The chief compounds of ammonia are as follows:—

Strong Solution of Ammonia,
Ammonia Water (Hartshorn) ...Dose, { 10 to 20 drops well diluted.
1 ounce of the strong solution mixed with 2 ounces of water.
Aromatic Spirits of Ammonia. Dose, { ½ to 1 tea-spoonful in water.
Carbonate of Ammonia.......... ,, 3 to 10 grains.
Chloride of Ammonium.......... ,, 5 ,, 20 grains.
Solution of Acetate of Ammonia (see under Section on Drugs that act on the Skin).
Bromide of Ammonium (see under Section on Drugs that act on the Nervous System).

Uses.—Ammonia is used externally as a stimulant. Thus the vapour of hartshorn and of carbonate of ammonia in the form of smelling-salts is employed in fainting and to relieve headache, when sniffed up the nose. It must not be used too strong, as it might excite inflammation. Applied to the skin as hartshorn it reddens the part, and is, therefore, used for rheumatic joints and as a liniment for other affections. Similarly when ammonia is taken into the stomach, either as hartshorn diluted, or as carbonate of ammonia, or as the aromatic spirit, it stimulates, producing a feeling of warmth in the stomach; and it excites the stomach and bowels to the expulsion of wind. For such a purpose the aromatic spirits are best.

The chloride of ammonium has a special action on the liver, and is largely used in tropical countries for congestion and other chronic liver diseases. Entering the blood it acts as a general stimulant, rousing the heart and nervous system, and rallying the vital powers in states of exhaustion, exciting also the air-passages and the nerves connected with the lungs and aiding in the expulsion of mucus from the air-tubes in chronic bronchitis. For these latter purposes 5-grain doses of the carbonate are best. If 30 grains of this drug be given well diluted it acts as an emetic, and is occasionally used for this purpose in chronic bronchitis and croup, as the vomiting expels also the material from the air-passages. Ammonia is used in cases of snake bite, and for relief of stings of insects. For the latter weak solutions of hartshorn are applied to the part, and act by destroying the poison of the bite; for the former 10 drops of the strong liquor diluted with 30 of water are injected into the veins, and act by their stimulating property on the circulation and nervous system.

What is said a little further on as to the uses of alkaline medicines in indigestion is applicable to ammonia, the preparation chiefly used being the aromatic spirits. It is not commonly employed alone but along with soda or potash and with some bitter infusion.

Magnesia.—The chief preparations of magnesia are:—

	Dose.
Carbonate of Magnesia...........	10 to 60 grains.
Fluid Magnesia (Solution of Carbonate of Magnesia)...	1 to 2 fluid ounces (2 to 4 table-spoonfuls).
Light Magnesia.......................	10 to 60 grains.
Heavy Magnesia (Ponderous Magnesia).....................	10 ,, 60 ,,
Sulphate of Magnesia (Epsom Salt)...........................	60 grains to ½ ounce.

Uses.—Magnesia is chiefly given for correction of acidity of the stomach and heartburn and

for acidity of the bowels. The carbonate, light and heavy magnesia are not easily dissolved, and they are therefore specially useful for acidity. They also act upon the bowels so as to cause a copious flow of watery secretion, producing loose motions. As they have not much stimulating effect they cause no griping pains and are thus useful for children, for whom they are often combined with rhubarb, as in Gregory's powder. A useful combination would be 5 drops or more of the aromatic spirits of ammonia. The action of Epsom salt will be discussed under Purgatives, in this section.

Magnesia in powder is, however, given too freely, and is apt to form little stony concretions in the bowel if persistently used in any quantity. Magnesia is a common antidote for poisoning with strong acids, oxalic acid, mercury, arsenic, and copper, as it forms with them insoluble salts.

Lime or chalk.—Its chief preparations are:—

	Dose.
Prepared Chalk (Carbonate of Lime)	10 to 60 grains.
Lime-water (shake up slaked lime in water. Allow to stand, and pour off the clear fluid)	½ to 4 ounces (1 to 8 tablespoonfuls).
Saccharated Solution of Lime	15 to 60 drops.
Chalk Mixture	1 to 2 ounces.
Aromatic Chalk Powder	10 to 60 grains.
Grey Powder (Mercury with Chalk)	2 to 8 grains.
Phosphate of Lime	10 to 20 grains.
Hypophosphite of Lime	5 to 10 grains.

Uses.—Lime is, like magnesia, exceedingly useful as a corrective of acidity and heartburn when given after food. It has also an astringent property, for which it is much used in looseness of bowels, specially in the form of chalk mixture, or for children the aromatic powder. Lime-water is given freely to children being artificially reared, much too freely in the author's opinion. Over and over again he has asked mothers and nurses for what purpose the lime-water was added to the milk; and if he has received any answer, for commonly no reason except that of custom or the advice of somebody supposed to know has been forthcoming, the answer has been that it was to help in the formation of the child's bones. This idea is quite incorrect, most of the lime is expelled in the motions. The actual reason for the addition of the lime-water is that it destroys—neutralizes—some of the acid of the gastric juice, and therefore prevents the rapid action of the juice on the milk, in short slows the process of digestion in the stomach. It must be remembered that the first effect of the gastric juice is so to act upon the milk as to separate it into a curd and whey, and then the curd is further attacked and broken down. Now mother's milk forms, in the stomach of the child, a very fine curd, in small flaky pieces which are easily digested. Cow's milk, however, forms much larger and more solid masses, which are apt to irritate the child's stomach and cause vomiting, griping pains, colic, diarrhœa, &c. The addition of the lime-water, by diminishing the acidity of the gastric juice, slows the process, so that smaller pieces are formed. It is, therefore, quite a correct thing to do *if it is necessary*, if, that is, the child shows any difficulty in digesting the cow's milk when prepared in a proper way (see p. 441), and if simple boiling, which prevents the milk curdling in large masses, does not prove sufficient to remove the difficulty. But the use of lime-water *as a matter of course* and without any proof of its necessity in the milk prepared for every hand-fed infant, and in every bottle, is a thing to be most strongly objected to and prevented. When it is necessary about one tea-spoonful of lime-water, or 15 drops of the saccharated solution, may be added to the milk. For diarrhœa a similar quantity and upwards may be used. The phosphate and hypophosphite of lime are the preparations employed in growing children suffering from chronic diarrhœa and general weakness, but they are more advantageously given in combination with tonics, as in Parrish's Chemical Food, Syrup of the Hypophosphites, &c. (see p. 817).

Chalk is employed as a dusting powder for burns, ulcers, and weeping patches of skin eruptions, for its soothing and astringent effect. Lime-water is used for the same purpose; and Carron-oil, a mixture of lime-water and linseed-oil, is one of the most soothing of applications to burns. Lime-water is also employed as a mouth-wash in ulceration, and for injection into the bowel to destroy round-worms.

The Uses of Alkalies.—The conditions under which acid tonics are found to be useful in indigestion have been stated in detail on p. 842, and enable one to understand also under which circumstances medicines of an opposite chemical character should be employed. The stomach juice is acid, and its flow will, therefore, be stimulated by a remedy of an opposite kind, soda or potash. The appropriate time, therefore, for the administration of alkaline tonics is immediately before food, so that the food afterwards introduced into the stomach is met by an abundant secretion of juice for its digestion. In all cases of slow digestion, in which the food lies like a weight for hours after it has been taken,

and after an hour or two, it may be, causes great uneasiness by the development of flatulence owing to improper fermentations arising, in all such cases alkaline remedies before food should first be tried, in preference to acid remedies taken after food. They are not usually taken alone, but in combination with some other substances, which will aid their stimulating action on the stomach. For example, a few grains—3 to 5—of bicarbonate of soda or potash, along with half a tea-spoonful of aromatic spirits of ammonia, and a tea-spoonful of a bitter tonic, say infusion of calumba, or other bitter infusion (see p. 840), or ½ tea-spoonful of compound tincture of gentian, in a wine-glassful of water, would make such a combination as would be found suitable for many cases of weak and sluggish digestion, or **atonic dyspepsia,** as it is called. If such treatment did not yield complete relief, then, after a time, one would substitute an acid tonic, taken *after food*, say 5 to 10 drops of dilute hydrochloric acid, along with a bitter infusion also.

An entirely opposite effect to that which has been described is obtained by giving soda or potash *after* a meal. Then the alkali simply mixes with the acid contents of the stomach and neutralizes some of the acid, so that the total acidity is diminished; it has then no effect upon the secretion of gastric juice. It is in cases of acidity and heartburn that the soda and potash are useful in this way. Here also it is well to give them in combination with such a preparation as the aromatic spirits of ammonia, which will aid in the expulsion of any wind that has formed. It is to be noted, however, that this use of alkalies is able to give only temporary relief. It diminishes the acidity at the time, but does not remove the condition which has been the cause of the disturbance. Acids given *before food* will, on the principle already explained, *restrain* the secretion of the acid gastric juice, and may thus prevent the excessive acidity from occurring at all. We may then usefully summarize the results of the employment of acids and alkalies in indigestion by the following table:—

Acids given after food increase the acidity of the gastric juice, Alkalies given before food stimulate the secretion of the gastric juice, ...	and thus promote digestion.
Acids given before food restrain the secretion of the gastric juice, ... Alkalies given after food diminish the acidity of the gastric juice,	and thus relieve acidity and heartburn.

In certain forms of diarrhœa, dependent upon the irritation produced in the bowel by the excessive acidity of the bowel contents, soda, potash, magnesia, and lime, by neutralizing some of the acid, are most valuable. The benefit derived from such drugs in increasing the alkaline character of the blood has already been pointed out on p. 818.

The principle that an alkaline solution will increase an acid secretion, but will restrain an alkaline one, explains the effect of a solution of carbonate of soda in certain skin diseases, accompanied by raw surfaces, which weep copiously, such as eczema. The fluid from the eczema is alkaline, and is much relieved by bathing with 30 grains of the carbonate to a pint of water. The itching of nettle-rash and other skin affections is often wonderfully relieved by a similar lotion, or one double the strength.

Artificial Digestive Agents.

The ferment—pepsin—present in the gastric juice can be separated from the stomach of animals, such as the pig and the calf, and can be prepared in a pure state, and administered as a medicine to those whose indigestion seems to depend upon deficient quantity or quality of the gastric juice. In the same way the ferment of the pancreatic juice—pancreatin—can be prepared and employed as a medicine. Recently it has been found that the juice of the papaw-tree has digestive properties resembling those of pepsin, and from it a ferment—papain—has been separated, of which we shall give also a brief note.

Pepsin.—The ordinary pepsin is prepared in the following way:—The stomach of a recently killed pig, sheep, or calf is opened up and laid on a board, inner surface upwards. Adhering portions of food, dirt, &c., are washed off by a gentle stream of cold water. The surface is then scraped with a blunt knife or other suitable instrument, and the scrapings spread on a surface of glass or glazed earthenware, and quickly dried at a temperature not exceeding 100° Fahr. The powder thus obtained is yellowish-brown, with a peculiar odour, and should be kept in a dry stoppered bottle. A glycerine extract of pepsin is easily made by stripping the inner lining membrane—the mucous membrane—off the stomach of a recently killed pig or calf, cutting the stripping up into small pieces, and pounding them up with glycerine. Leave the mixture for eight days, and then press the fluid through cloth. The glycerine extract so obtained will show all the active properties of pepsin.

Pepsin	Dose 2 to 10 grains with food.
Saccharated Pepsin	,, 5 to 15 ,,
Liquor Pepticus	,, 1 tea-spoonful.
Acid Glycerine of Pepsin	,, 1 to 2 tea-spoonfuls in water.
Pepsin Wine	,, 1 to 2 tea-spoonfuls with food.

Uses.—If a glass beaker or tumbler be taken, a quarter full of water, and if into it be placed some pieces of lean meat, cut very small, small pieces of cooked egg, small pieces of fish, &c., and if there be added to the water a similar quantity of the solution of hydrochloric acid (4°/$_o$), and a pinch of pepsin, or a tea-spoonful of liquor pepticus, and the glass vessel be then set aside, and kept at a temperature of 100° Fahr., in three or four hours the contents will be partially digested, and the fluid will have acquired a pea-soup appearance and a peculiar odour. If a second tumbler be similarly prepared, and have the same contents, except the pepsin, the fragments of food will show only a swollen gelatinous appearance, no evident solution having occurred; or, if, again, a third tumbler be prepared, and pepsin be added, but no acid, little or no change will occur. In short, for purposes of digestion, both pepsin and acid must be present. If, therefore, one is administering pepsin as an aid to digestion, it is well to give it in an acid solution, in combination, that is, with hydrochloric acid. Now, 6 drops of hydrochloric acid in 1¼ ounce of water give a strength of hydrochloric acid about equal to ·4 per cent, and 6 drops in 2½ ounces of water, or the average sherry-glassful, are equal to ·2 per cent, the exact strength of the acid of the gastric juice, so that 2 to 5 grains of pepsin, 6 drops of dilute hydrochloric acid, and half to one wine-glassful of water would meet the requisite conditions. The cases in which pepsin is considered desirable are those of general debility and anæmia (bloodlessness), where, owing to the general weakness, a deficient supply of gastric juice is the cause of indigestion; and also cases of chronic catarrh of the stomach, such as the chronic dyspepsia of drunkards. It is also needed in cases of irritable stomach, when pain after food is a frequent symptom and subsequent vomiting; in cases of ulceration of the stomach, in which the desire is to relieve the stomach of its work as much as possible; and in the weak digestion of the old and of infants. Of course in the case of children much smaller doses would be employed.

A caution against the routine use of pepsin must be given. It must be noted that if the work of the stomach is done for it, there will be a tendency to lower the activity of the stomach, and if this is long and constantly persisted in, the stomach will become less and less able to do its business. It is, therefore, always desirable to use other remedies to correct indigestion, stimulating remedies with a view to stirring up the stomach to perform its duties, such as the acid or alkaline tonics already noted, combined with tonics to the nervous apparatus of the stomach, such as nux-vomica; and pepsin preparations ought to be employed only for a time to tide over some temporary difficulty. In short, pepsin should be of the nature of a last resort, and never a first.

Liquor pepticus is a solution of pepsin, and may be employed in such cases as pepsin itself. The liquors of Savory and Moore or of Benger are those most widely used.

In cases where it becomes absolutely necessary to relieve the stomach of some or the most of its work by partially digesting the food artificially, such as cases of ulceration of the stomach, and in the case of children, not being nursed by the mother, in whom the stomach rejects cow's milk, condensed milk, and all forms of prepared food, it is customary to effect the object by adding the digestive agent to the food sometime before it is administered, and thus accomplishing the partial digestion before it reaches the stomach at all. Pepsin is not commonly employed for this purpose, because it digests only one class of food-stuffs, namely proteids. The addition of pepsin and acid to milk, for example, would effect only the digestion of the curd of the milk (see p. 549 for composition of milk), and would leave unaffected the cream or fat of the milk. If it were added to a mixture of milk and arrow-root it would not act upon the arrow-root at all, pepsin not digesting starch (see p. 586). When digestion of food is to be accomplished before its administration, therefore, pancreatin or liquor pancreaticus (see below) is employed, since it acts not only on albuminous, but also on starch and fatty foods (see p. 145).

Pancreatin is derived from the sweet-bread or pancreas of the pig. It is a mixture of ferments, one of which is capable of digesting albuminous substances, a second starchy foods, and a third fatty materials. A glycerine extract of pancreas may be prepared by cutting up the fresh sweet-bread of the pig and pounding it up in glycerine, letting it remain so for eight days, and then straining it through cloth. In the market there are several very active solutions of the pancreatic ferments, the best known being the liquor pancreaticus of Savory and Moore

and the liquor pancreaticus of Benger. Zymine is a preparation in the form of a yellowish powder obtained from Burroughs, Welcome, & Co., London.

Preparations:

	Dose.
Pancreatin	2 to 4 grains.
Liquor Pancreaticus	1 to 2 tea-spoonfuls in water with a pinch of baking soda 2 or 3 hours after a meal.
Pancreatic Emulsion prepared with the pancreas of the pig and fat and flavoured	1 to 3 tea-spoonfuls in a little milk or water 2 or 3 hours after a meal.

Now a set of experiments with pancreatic solutions may be made in tumblers, such as have been described for pepsin. They show that pancreatin or liquor pancreaticus alone, added to a tumbler containing water and small pieces of food-stuffs, will scarcely act at all. Nor yet will any action whatever occur if acid be added to the solution. But if to the food and pancreatic extract in the tumbler be added a good pinch of bicarbonate of soda, in an hour or two the digestion of the food will be far advanced. That is to say, *while pepsin acts in an acid solution, pancreatic juice requires to be alkaline.* Moreover, if the experiments with the pepsin and pancreatin be kept going side by side, and be carefully watched, two further differences between the digestive agents will be observed. In the tumbler containing the peptic ferment, any fat present will be found floating on the surface of the liquid, and starch will remain unaltered; but in the tumbler with the pancreatic ferment, these as well as the meaty constituents of the food will be found to undergo change. Moreover if the two ferments be left for many hours at work, the tumbler containing the pancreatic ferment will by and by give off an unpleasant odour, showing that the pancreatic juice not only converts all the varieties of food into a condition in which they are fitted to enter the blood, but is capable of acting upon them still further and decomposing them into simpler bodies. In short, a putrefactive change follows that of digestion, which does not occur in the case of pepsin. These facts serve to point out two conditions for the use of the preparations of the pancreas in indigestion.

The first is that it is of little or no use to give pancreatin or liquor pancreaticus by the mouth in a mixture, as one administers pepsin, because as soon as it reaches the stomach it is plunged among an acid fluid and is, therefore, inert. It is possible that it may pass through the stomach unaltered, and when it reaches the small intestine, and the food becomes there alkaline by admixture with the bile, that it then becomes active. But at any rate it is plain that it is useless to give it with the expectation that it will aid digestion *in the stomach.*

When it is given with the desire of reaching the small bowel, it should be given with soda *two hours after a meal.*

The second fact indicated concerning pancreatic preparations is that they will be specially useful for digesting foods previous to administration, since they may be mixed with any kind of food, acting upon all kinds. All that is needful is to mix the liquor pancreaticus *and a pinch of bicarbonate of soda* with the food and keep it warm. Care must be taken that the ferment is not allowed to act too long before the food is to be used, else the food will have acquired an unpleasant bitter taste and perhaps an odour of decomposition. This may be avoided by using the food a short time after the ferment has been added, 20 to 30 minutes, or by boiling the food after that interval, which destroys the ferment, hinders any further action, and, therefore, permits the food to be kept as long as may be necessary.

A few directions for the use of liquor pancreaticus, the most commonly used preparation, may here be given.

For Milk.—To four tea-cupfuls of milk add one tea-cupful of cold water, divide the mixture into two equal parts, bring one-half to the boiling point, then mix the boiling portion and the cold portion together. This gives the mixture a temperature favourable to the action of the ferment. Now add a tea-spoonful of liquor pancreaticus and a good pinch (15 grains) of bicarbonate of soda: stir the mixture, and set it aside in a warm place (where it will simply be kept warm, without being made hotter) for 30 minutes. Then boil, and use as required.

For Tapioca, Rice, Sago, Corn-flour, Porridge, Gruel, or similar preparation.—Make the tapioca, gruel, or whatever it may be in the usual way but very thick. Mix thoroughly a tea-cupful of the food, when quite ready and boiling hot, with the same quantity of cold milk. Then add one or two tea-spoonfuls of the liquor pancreaticus and the large pinch of soda; mix well; set in a warm place for 20 to 30 minutes. If the solution is acting properly, the thick mixture will become perfectly fluid, and it may be immediately supped, as it is, or after being boiled.

For Beef or Chicken Tea.—The lean beef or chicken should be scraped down into a pulp, as

ordered for beef-tea (see p. 627), mixed with the proper quantity of water, and brought up to a blood-heat (100° Fahr.). Then stir in 2 or 3 tea-spoonfuls of liquor pancreaticus with half a tea-spoonful or thereby of bicarbonate of soda—that is to 1 lb. of meat scrapings and 4 breakfast-cupfuls of water. Keep the mixture at the temperature named for 1 hour or 1½ hour, tasting it from time to time, however, to see that the action of the ferment is not proceeding too far to the development of a disagreeable flavour; after a sufficient time boil, and use as required. If it is desired to thicken the beef-tea with flour, arrow-root, &c., such should be separately prepared, properly boiled, and then added to the cold meat and water, and when a proper temperature is secured, the ferment is added. The starch of the arrow-root, &c., will thus also be acted on. These directions will enable one to prepare and artificially digest almost any kind of food. It may be added that the London chemists, Burroughs, Welcome, & Co., put up their pancreatic powder, called zymine, in glass tubes along with the necessary soda, in quantity sufficient for the predigestion of one pint of milk. They are called **peptonizing powders.**

Liquor pancreaticus is especially valuable for adding to preparations of food used for injecting into the bowel in cases where food cannot be taken by the mouth. Thus milk may be prepared lukewarm with the addition of two tea-spoonfuls of the liquor and a large pinch of soda, and injected. A mixture of boiled arrow-root and strong beef-tea with the liquor pancreaticus and soda may be similarly used (see p. 873, for other nourishing injections).

Papain is a digestive ferment derived from the juice of the papaw-tree, *Carica Papaya.* It acts on albuminous food like pepsin. "The fruit of the papaw-tree has long been used in the West Indies to render beef tender. The unripe fruit is split open and rubbed over the surface of the meat previous to cooking."

Uses.—Papain is not very extensively used for indigestion, though it is useful in cases to which pepsin is applicable. It has been more largely used to dissolve warty growths and false membranes. The author has found it dissolve the false membrane of diphtheria with great rapidity in several cases. The solution recommended contains 12 grains of papain, 5 of borax, and 2 drachms of water, and it is painted on with a camel-hair pencil twice daily or oftener. In one or two days the membrane comes away on the brush in large portions. In urgent cases it might be used every hour or even oftener.

Ingluvin is a special American preparation, said to be prepared from the gizzard of the domestic fowl. Though recommended as a substitute for pepsin it has not been shown to have much action on coagulated egg albumen. It has been recommended specially for obstinate vomiting, and in particular for the vomiting of pregnancy. The dose is from 5 to 10 grains.

Lactopeptine is another preparation of ferments vaunted in the treatment of dyspepsia and other chronic affections of the stomach. Its dose is 10 to 15 grains.

Remedies for Flatulence of the Stomach.

The distension of the stomach with wind is a consequence of some kind of improper digestion. If the proper fermentive process does not take place, changes of decomposition occur, with the development of gas, and painful distension results, which by pressure interferes with neighbouring organs and specially the heart. The obvious remedy for this state of things is that which will correct the error of digestion, for if natural digestion be restored the production of gas will not occur. To this end probably the alkaline tonic with aromatic spirit of ammonia and a bitter tonic (see p. 844) taken before food would be useful. But while the discomfort and pain of the flatulence are present, the desire is for some means of exciting the stomach to expel the wind. There are many drugs which do this, but it is well to insist on the fact that they can afford only temporary relief. They dispel the wind at the time, but they give no guarantee that an hour or two after the next meal the same state of things will not be repeated. Every sufferer in this way ought, therefore, to seek to find some more permanent relief by finding some remedy for the improper digestion which is the cause of the disturbance. Substances which aid in the expulsion of gas from the stomach do so by stimulating the movements of the stomach wall, and it may be causing the communication between the lower end of the gullet and stomach to dilate so as to allow of the escape of the gas. Such substances are called **carminatives,** and they are usually aromatic substances such as allspice, anise, assafœtida, camphor, cinnamon, cloves, cayenne, caraway, cardamoms, coriander, dill, ginger, horse-radish, mace, mustard, nutmeg, pepper, peppermint, valerian, and stimulants, like ether alcohol and chloroform, and ammonia.

We shall give a list of the chief of their preparations and doses, and shall afterwards consider a few of them in more detail.

	DOSE.
Oil of Anise	2 to 5 drops on sugar.
Essence of Anise	10 to 20 drops.
Water of Anise	½ to 1 tea-spoonful.
Tincture Assafœtida	½ to 1 tea-spoonful.
Fœtid Spirit of Ammonia—Assafœtida 1½ ounce, strong solution of Ammonia 2 ounces, Spirit (proof) 20 ounces	½ to 1 tea-spoonful.
Pill Assafœtida	1 to 2 pills.
Compound Assafœtida Pill	1 to 2 pills.
Enema Assafœtida	30 grains powdered Assafœtida in 4 ounces of water.
Oil of Cajuput	1 to 3 drops.
Spirit of Cajuput	30 to 60 drops.
Camphor Water	1 tea-spoonful.
Oil of Caraway	2 to 5 drops.
Water of Caraway	1 to 2 ounces.
Compound Tincture of Cardamoms	½ to 2 tea-spoonfuls.
Tincture of Cayenne	2 to 10 drops well diluted.
Cinnamon Water	1 to 2 ounces.
Oil of Cinnamon	1 to 4 drops.
Compound Cinnamon Powder (Aromatic Powder)	3 to 10 grains.
(Equal quantities of Cinnamon, Cardamoms, and Ginger.)	
Tincture of Cinnamon	½ to 2 tea-spoonfuls.
Oil of Cloves	1 to 4 drops.
Infusion of Cloves	1 to 2 ounces.
Oil of Coriander	2 to 5 drops.
Powdered Coriander	20 to 60 grains.
Oil of Dill	1 to 4 drops on sugar.
Dill Water—The best for children	1 to 4 tea-spoonfuls in water.
Fennel Water	1 to 2 ounces.
Ginger Powder	10 to 20 grains.
Essence of Ginger	5 to 20 drops.
Syrup of Ginger	1 to 4 tea-spoonfuls.
Tincture of Ginger	10 to 30 drops.
Compound Spirit of Horse-radish	1 to 2 tea-spoonfuls.
Oil of Nutmeg	2 to 6 drops.
Spirit of Nutmeg	30 to 60 drops.
Oil of Pimenta (Allspice)	1 to 3 drops.
Pimenta Water	1 to 2 ounces.
Peppermint Water	1 to 2 ounces.
Oil of Peppermint	1 to 5 drops.
Essence of Peppermint	10 to 20 drops.
Spirit of Peppermint	15 to 30 drops.
Oil of Spearmint	1 to 5 drops.
Water of Spearmint	1 to 2 ounces.
Spirit of Spearmint	5 to 20 drops.
Infusion of Valerian	1 to 2 ounces.
(120 grains Valerian Root infused for 1 hour in ½ pint of boiling water.)	
Tincture of Valerian	1 to 2 tea-spoonfuls in water.
Ammoniated Tincture of Valerian	½ to 1 tea-spoonful.
Aromatic Spirit of Ammonia (see p. 843).	

These substances act by exciting the circulation in the stomach, causing a sense of heat and increased appetite, and aiding the digestion of food. They excite the nerves and relieve pain, and by stimulating the muscular movements of the stomach help to expel wind. An excellent combination for this would be half a tea-spoonful of aromatic spirits of ammonia, a few drops of tincture of cayenne, and a tea-spoonful of bitter infusion in half a wine-glassful of water.

Most of these remedies are also useful in the relief of spasm or cramp of the stomach or bowels. This consists in irregular and excessive contraction of part of the muscular wall of the intestinal tube. The remedy relieves it by exciting the natural movement as a whole, causing expulsion of the cause of irritation. These remedies are, therefore, also called **anti-spasmodics**.

Assafœtida as used in medicine is a gum resin obtained from the root of *Narthex assafœtida*, an umbelliferous plant, native of Persia, Afghanistan, and the Punjaub.

It is a powerful stimulant to the nervous system, very valuable for the relief of spasm, specially of a hysterical kind. Its unpleasant odour is the only objection to giving it for relief of flatulent distension of the stomach. This objection is overcome in the case of the bowels by giving it as an enema (see p. 874). It is valuable in hysterical affections at the period of change of life; and its antispasmodic effects are likewise available in whooping-cough, asthma, and other nervous diseases.

Anise, the fruit of *Pimpinella anisum*, **Fennel,** the fruit of *Fœniculum dulce*, imported from Malta, **Dill Fruit,** the dried fruit of *Anethum graveolens*, **Caraway,** the dried fruit of *Carum Carui*, **Coriander,** the dried ripe fruit of *Coriandrum sativum*, are substances all belonging to the same natural order—*Umbelliferæ*, and all yielding preparations which have similar effects on the body and are used for similar purposes.

They have all a stimulating effect upon the stomach and bowels. They may be used alone to relieve flatulence, and one or other is commonly given along with purgatives to diminish any tendency to griping. Anise and dill are specially used for children, for whom they are very useful.

Cloves belong to the *Myrtaceæ* order of plants and may be taken as a representative of this class of remedies. From all of them an aromatic essential oil may be distilled, which possesses the chief qualities of the remedy. These essential oils, when applied to the skin,

redden it, causing smarting at first, but later diminishing the sensibility of the part. They prevent decomposition. When taken internally, they act upon the mucous membrane of mouth, gullet, stomach, and bowels, as they act upon the skin, producing stimulation of nerves, exciting a freer flow of blood, causing increased appetite, and increased digestive power, relieving pain, hiccup, &c., and aiding in the expulsion of wind. Oil of cloves is used as an application for toothache because of its soothing effects following the first stimulating effect.

Cajuput is derived from the leaves of *Melaleuca minor* or cajuput-tree, growing in the Molucca Islands, the oil being imported from Batavia and Singapore. It and **allspice** or pimenta belong to the same order as cloves, and have similar actions.

Cardamoms and **Ginger** belong to the same natural order (see p. 594). They are both of them widely used as remedies for flatulence, usually in combination with other medicines, such as tonics. For example, the compound tincture of cardamoms or the tincture of ginger would be a useful addition to a tonic for indigestion.

Camphor is a solid volatile oil, obtained from the wood of *Camphora officinarum*, belonging to the same order as cinnamon, Lauraceæ. Rough camphor is imported from China and Japan and is re-sublimed in England.

Use.—It stimulates the skin and is a powerful irritant to raw surfaces and to mucous membranes. On this account it is employed for liniments and oils, as applications to sprains, painful and enlarged joints. It is destructive to low forms of animal life, and is used, therefore, for antiseptic purposes, along with carbolic acid, for decayed teeth, &c. It is its stimulating properties that make it useful, when taken internally, for flatulence and diarrhœa, in hysterical vomiting and the early stage of cholera. But when given in large doses it produces sickness and vomiting, by its irritant effects. It also stimulates the heart and circulation, when taken internally, and the nervous system. Because of its stimulating effects on the nervous system, it has been given in prostration of fevers, in poisoning by opium, and in various nervous affections. In overdoses it produces a species of intoxication, with confusion of speech and mind, and later convulsions. It stimulates the air-passages also, and is frequently used in combination with other substances as a cough mixture, and it acts also on the skin. In common cold-in-the-head it has been found useful when inhaled as a vapour, 30 to 60 grains in ½ pint hot water.

Its chief preparations are:—

	Dose.
Camphor Water	1 tea-spoonful.
(Place 30 grains crushed camphor in a small muslin bag in 1 pint of water for 2 days.)	
Spirit of Camphor	10 to 30 drops.
Compound Tincture of Camphor	15 to 30 drops.
(Contains opium—used for cough, and called Paregoric Elixir.)	

Cinnamon (see p. 595) is specially useful in combination with drugs for diarrhœa, because, besides its aromatic oil, it contains tannic acid properties, and has therefore an astringent as well as a stimulating action on the stomach and bowel.

Peppermint (see p. 594) is one of the most common remedies for flatulence and colic, either alone or in combination with purgatives, or, in cases of diarrhœa, with astringents. Rubbing the skin of face and hands and other exposed parts with soap strongly scented with peppermint or lavender prevents mosquito bites. Hanging a sprig of the plant or of pennyroyal near the head during sleep is said also to be useful, or a small bottle containing the volatile oil.

Spearmint has similar properties to peppermint.

Valerian—the dried roots and rootlets of *Valeriana officinalis,* plants growing wild and cultivated in Britain. The preparations of valerian have a strong stimulating effect upon the stomach and bowels, heart and nervous system. It is specially used for hysterical flatulence, fainting, palpitation, and convulsions. In large doses the oil paralyses the nervous system.

Besides these remedies creasote, sulphurous acid, and carbolic acid have been given for flatulence, and also charcoal. The idea of using the three former substances is that they prevent changes of decomposition occurring which may be the cause of the flatulence. They may be tried in drop doses diluted. The object of using charcoal is to diminish distension by the absorption of the gas. For this purpose a half tea-spoonful of the powder may be used.

Emetics.

These are substances which cause the stomach to expel its contents by way of the mouth (Greek *emeo,* to vomit). Some substances produce this action by influencing the stomach itself, by an irritating effect upon its walls. This is the way in which mustard acts, for example, car-

COMMON POISONOUS PLANTS.

Plate XI.

PURPLE FOXGLOVE or FOLKSGLOVE.
(Digitalis Purpurea.)

COMMON GREATER or SPOTTED HEMLOCK.
(Conium Maculatum.)

FOOL'S PARSLEY or LESSER HEMLOCK.
(Æthusa Cynapium.)

bonate of ammonia in large doses, infusion of chamomile flowers, salt and water, sulphate of zinc, alum, and sulphate of copper. Large draughts of warm water act by their mechanical bulk. These are called **direct emetics.** On the other hand there are a few drugs which excite vomiting by acting on the nervous system, and may produce their effect without entering the stomach at all, such as, among others, tartar emetic, ipecacuanha, apomorphia. That vomiting may be principally dependent upon nervous changes is shown by the fact that mere impressions upon the nerves of sight, taste, smell, may excite it, or the mere idea or recollection of such impressions, as the recollection of a disgusting smell or sight, &c., and by the fact that vomiting is a very common symptom in irritation of the brain, as in inflammation of the membranes of the brain, and the pressure of tumours or effusions on the brain. Then the induction of vomiting by tickling the throat with a feather, or by passing the finger into the throat, is an illustration of reflex nervous vomiting. The occurrence of vomiting in disease of kidneys, ovaries, womb, &c., is another illustration of the same thing, the stomach being acted on by nervous impressions conveyed from the diseased organ.

It is to be noted that vomiting is not a simple act of expelling the contents of the stomach. Other organs are influenced more or less, according to the nature of the agent used to excite the act. Usually there is general depression, enfeeblement of the circulation, weakening of the action of the heart, languor, and muscular weakness. The air-passages are affected, air being pressed out of the lungs by the compression of the abdomen. In bronchitis, croup, and other diseases of the air-passages, this effect is beneficial by clearing the tubes of phlegm, &c. Often, moreover, the emetic used has a stimulating action upon the respiratory passages, such as ipecacuanha, so that the sweeping out of material from the lungs is more effectually secured. The act of vomiting is also accompanied by increased secretion of sweat, saliva, and mucus from the glands of the throat and air-passages. The pressure exerted upon the abdomen in the act of vomiting expels bile from the gall-bladder, and is sometimes made use of to get rid of gall-stones lodging in the bile-duct. Now it will be understood that the additional effects on the heart and circulation, lungs and nervous system, are much more marked in the case of drugs which act through the general system, and much less marked, or not marked at all, in the case of emetics acting simply locally on the stomach. Mustard and water given for the purpose of emptying the stomach and getting rid of a mass of ill-digested and irritating food will rather produce a sense of comfort and well-being than a feeling of depression. Tartar emetic, on the other hand, produces great depression, and might cause serious weakening of the circulation and collapse in delicate persons. Therefore, in selecting an emetic, one ought to consider the other effects the emetic may produce, and whether it is advisable, in the particular case, to risk them or not. The mere increased pressure upon certain organs, specially upon the lungs and blood-vessels, must not be forgotten, and it will show the need of refraining from the use of such substances in the case of persons with weak blood-vessels, liable to attacks of bleeding.

We will now consider some of the details connected with the action of the drugs used as emetics.

Lukewarm Water given in large draughts is one of the simplest and safest of emetics, and may be used to rid the stomach of irritating masses of food, in sick headache, or to aid in the expulsion of some piece of food lodged in the upper part of the gullet. Salt and water, a table-spoonful in a tumbler of warm water, are also employed for a like purpose.

Mustard and Water.—One or two tea-spoonfuls of mustard to a tumblerful of hot water is more expeditious than simple lukewarm water, and is employed under similar circumstances. It is the means most ready to hand in cases of poisoning, and in cases of laudanum-poisoning it is to be preferred to sulphate of zinc or copper, since the laudanum may so deaden the susceptibility of the stomach walls that it is impossible to induce vomiting, and the use of the stomach-pump may be necessary. In such a case the substance given as an emetic remains in the stomach and may be absorbed. In the case of mustard no harm will be done; in the case of zinc, &c., harm might arise.

Infusion of Chamomile Flowers.—Emetic dose, 5 ounces or upwards. See p. 840.

Carbonate of Ammonia.—30 grains in water, as an emetic. See p. 843.

Zinc.—The chief preparations of zinc used as emetics are as follows:—

Sulphate of Zinc....	Emetic dose,	10 to 30 grains.
Acetate of Zinc.......	,,	10 ,, 20 ,,

Sulphate of zinc is employed as an emetic when an effect is speedily desired. Besides rapidity of action, very necessary in cases of poisoning, it possesses the property of producing

little depression. It is chiefly in cases of poisoning it is employed.

Preparations of zinc are also employed for their tonic and astringent properties, and are considered further on p. 869.

Copper.—

Sulphate of Copper.........Emetic dose, 5 to 10 grains.

Preparations of copper are chiefly used for external application, but some of its salts are noted on p. 869 later in this section. As an emetic the zinc sulphate is preferred.

Alum.—

Dried Alum......Emetic dose, 30 to 60 grains.

Alum is mainly used as a local application, for washes, gargles, &c., and is considered further on in this section (p. 868).

Ipecacuanha belongs to that class of emetics which act upon the general system. It will be suitable here to consider all its actions upon the body, and the chief preparations. The plant is called the *Cephaëlis Ipecacuanha*, and it is the dried roots that are used. These are dull-gray, bent and twisted, with a thin, white, finely-porous core, and a thick wrinkled bark, presenting the appearance of a series of rings threaded on to the core. The root is powdered, and besides starch, gum, &c., contains the active principle emetin and ipecacuanhic acid, a substance allied to tannic acid.

Preparations:—

	DOSE.
Powdered Ipecacuanha	½ to 2 grains as expectorant. 15 to 30 ,, emetic.
Ipecacuanha Wine....	5 to 40 drops as expectorant. 3–6 tea-spoonfuls as emetic.
Compound Ipecacuanha Powder (Dover's Powder) (1 grain of Ipecacuanha, 1 grain of Opium, 8 grains Sulphate of Potash), .	5–10 grains (*for adults only*).
Syrup Ipecacuanha (an American preparation)	2 to 30 drops as expectorant. ½ to 1 ounce as emetic.

Ipecacuanha powder has marked irritating properties. Dust of ipecacuanha in process of grinding gaining entrance to the nostrils, and air-passages in general, produces all the symptom of a severe cold in the head, sneezing, swelling of the lining membrane of the nostrils, coughing, and a species of hay-asthma; and it may even produce a pustular eruption. When the wine is used as a spray to the throat, its stimulating qualities cause increase of the secretion of the throat glands, and relieve dryness of the parts and cough and irritation arising therefrom. Taken into the stomach it produces similar effects. If the dose be small, it acts as a stimulant to the stomach, and produces frequently marked beneficial results by the stimulus, specially in catarrhal conditions of that organ. In larger doses it excites sickness and vomiting by the marked irritation it produces. It acts very quickly, and for this purpose a good method of administration consists in giving 5 grains of the powder in water every 5 minutes till the effect is produced. Gaining entrance to the blood, it acts on the lining membrane of the air-passages, increasing the phlegm, and rendering it more fluid. It is thus specially in cases where the expectoration is scanty or tough and expelled only with difficulty that ipecacuanha should be employed. It is widely used in bronchitis of children to aid in the removal of the phlegm, and in whooping-cough also. It acts also on the skin, and in common colds, in combination with opium as Dover's powder, it is one of the best of remedies. It is employed also for its effect on the liver by increasing the secretion of bile, and for its stimulating effects on the bowel in dysentery. Its praises have been sung in the acute dysentery of the tropics. For this purpose it must be given in large dose—30 to 90 grains, and it is said such doses may be given in this disorder without inducing vomiting, if the patient will keep lying quietly on the back. In suitable cases the motions become natural in character and frequence, and straining and griping disappear. After a large dose—60 to 90 grains—a second will not be required for 10 to 12 hours, if any second be needed at all. Instead of being given by the mouth it may be injected into the bowel—30 to 60 grains suspended in a small quantity of gummy fluid, three or four times a-day. It is also worth trying in the diarrhœa of children, when the stools are slimy and green. One or two drops of the wine every hour are recommended; and all the more if vomiting also be present. It may appear strange that a drug given to produce vomiting should also be able to allay vomiting, but it appears to yield much relief in some forms of the vomiting of pregnancy, that form which occurs soon after waking, and also in those cases where sickness, heartburn, and flatulence are associated. One drop of the wine every hour or several times a-day is recommended by Ringer for this purpose, and for the morning sickness of drunkards. The vomiting due to cold-in-the-stomach—gastric catarrh—which is frequently also attended by purging, will almost certainly be relieved by a dose of the Dover's powder, repeated in 3 or 4 hours. A spray of ipecacuanha wine is highly

recommended by Dr. Ringer to relieve the cough, tightness of the chest, and difficult breathing of "winter cough." The person should breathe deeply at every squeeze of the spray-ball to get the vapour well into the air-passages, and two or three squeezes should be used at each sitting, and repeated twice daily or so.

Emetin, the active principle of ipecacuanha, is used as an expectorant in doses of $\frac{1}{200}$ grain and as an emetic in doses of $\frac{1}{6}$ to $\frac{1}{3}$ grain. It is very powerful, and not to be used except by medical orders.

Tartar Emetic—Antimony.—Antimony is a metal. It is not employed in medicine in its metallic state. Its chief preparations used in medicine are:

Tartar Emetic or Tartrated Antimony....	Dose,	as an expectorant $\frac{1}{16}$ to $\frac{1}{6}$ grain, as an emetic 1 to 2 grains.
Antimonial Wine..................................	,,	to cause sweating 10 to 40 drops, as an emetic $\frac{1}{2}$ to 1 teaspoonful repeated.
James's Fever Powder (1 part of Oxide of Antimony with 2 of Phosphate of Lime).	,,	3 to 10 grains.

Another preparation of antimony, the "butter of antimony," properly the solution of the chloride of antimony, is used by veterinary surgeons for application to foul sores and malignant surfaces to cleanse them. An ointment of tartar emetic (1 of tartar emetic to 4 of lard) is used for enlarged joints, in cases of neuralgia, and as a stimulating application to the chest in bronchitis, whooping-cough, &c.

Uses.—The ointment of tartar emetic applied to the skin reddens it and brings out a crop of pimples which become pustules. It is irritating, that is to say. Now when tartar emetic is taken into the stomach in *small quantity*, it is mildly irritating, producing a feeling of warmth at the stomach; sweating also follows. In slightly larger doses the irritating action produces loss of appetite, sickness, weakness of the circulation, and a feeling of feebleness and depression. At the same time the secretion from the glands of the stomach, bowels, respiratory passages, and skin is increased. After larger doses vomiting occurs with great weakness and depression and muscular relaxation, and after poisonous doses the symptoms of irritation of stomach and bowels are marked. There occurs diarrhœa, the pulse is small and quick, and the skin is covered with cold clammy sweat. The symptoms are very like those of cholera, cramps of the extremities also occur, and before death sometimes delirium and convulsive spasms.

Tartar emetic is used chiefly for its emetic and depressing properties, but it is not resorted to now nearly so much as formerly. On account of its marked effect in reducing the strength and frequence of the pulse it used to be much employed at the beginning of fevers, and during the course of acute inflammations of lung, bowels, brain, &c. Its effect in stimulating the skin made it still more useful in these conditions. For these objects, however, it is scarcely now employed, except in acute inflammations in otherwise perfectly healthy and robust persons. To cause vomiting in order to get relief in bronchitis or croup or whooping-cough, ipecacuanha is preferred. Emetics have been found very useful to cut short attacks of malarial fever, such as ague, when accompanied by a purgative and followed by the administration of quinine.

Antimony in any of its forms should never be administered to the very young, very old, or feeble; and indeed what has been said ought to be sufficient to deter unskilled persons from its use.

Plummer's Pill is a mixture of calomel, sulphurated antimony, guaiacum resin, and castor-oil, and the presence of the antimony is supposed to increase its stimulating effect upon the liver, causing an increased outpour of bile into the bowel.

The use of antimony sometimes brings out a pustular eruption on the skin.

Poisoning by antimony is to be treated by administering solutions of tannin, easily obtained from strong infusions of tea, or oak-bark, or cinchona. Stimulants ought also to be given to relieve depression, diffusible stimulants like ammonia being preferred.

Apomorphia is made from morphia by heating it in a closed tube with concentrated hydrochloric acid. It is one of the most certain of emetics, and causes neither irritation of the stomach nor diarrhœa. It induces vomiting, not by acting on the stomach, but by its influence on the nerve-centres, and as the dose is small it can be injected under the skin by the hypodermic method (see p. 813). The dose, when thus used, is $\frac{1}{20}$ to $\frac{1}{10}$ grain. If taken by the mouth, a dose of $\frac{1}{10}$ to $\frac{1}{6}$ grain is required. In a few minutes after injection there is sickness, not excessive, and free vomiting, and depression does not last long. Apomorphia is now employed when speediness of action is desired, as in cases of poisoning, and in cases of lodgment

of foreign bodies or masses of food in the gullet. It is not a substance, however, to be employed by any but a skilled person, and certainly not in the case of children, except by some responsible person who is well acquainted with the materials he is using.

Remedies which Soothe the Stomach.

All the substances which we have been hitherto considering in this section act as stimulants to the stomach, increasing the activity of its circulation, the energy of its movements, and the excitability of its nerves. It is very frequently necessary to produce quite contrary effects, to diminish the circulation, to quiet the churning movements, and to dull the nervous sensibility. Remedies which do this are called **gastric sedatives.** The indications for the need of such treatment are an excessive irritability, which causes the stomach to eject its contents by vomiting, or to threaten to do so, pain, and sometimes diarrhœa, caused by the food being hurried out of the stomach before it has time to be digested, a kind of diarrhœa which is recognized by its being almost invariably set up a very short time or only a few minutes after food is taken. Substances which thus soothe the stomach may do so directly. For example, if marked irritability of the stomach be due to excessive acidity of its contents, a few grains of bicarbonate of soda, by neutralizing the excess of acid, will procure relief and quiet down the organ. In like circumstances a glass of warm water is often sufficient to procure relief. Or if the irritability be due to flatulent distension, some of the agents for expelling wind—ginger, peppermint, &c.—may have a similar calming effect. This action is due to the direct influence on the stomach itself and its contents. On the other hand, other remedies act in a more general way, through the blood and nervous system. Opium is an excellent example of this class, acting as a sedative to the stomach by its effect upon the nerves.

Ice is the most powerful of local sedatives to the walls of the stomach. It is simple, and in cases of pronounced irritability, evidenced by the vomiting of everything taken, no matter how small in quantity, ice should be resorted to. The ice should be swallowed in small pieces, and milk ought to be iced and sips taken at frequent intervals. The application to the walls of the abdomen over the region of the stomach of mustard poultices will aid the treatment materially.

Bismuth is one of the chief local soothing agents in stomach irritability. Bismuth is a metal; its chief preparations are as follows:—

Carbonate of Bismuth	Dose,	5 to 20 grains.
Subnitrate of Bismuth	,,	5 to 20 ,,
Bismuth Lozenges	,,	1 to 6 lozenges.

2 grains of subnitrate in each lozenge.

Uses.—Bismuth in the form of subnitrate is used to allay irritation outside the stomach, as a dusting powder, wash, or ointment to chapped hands and nipples, and to weeping sores such as the raw surface of eczema. Used as snuff it is very valuable in the commencing stage of cold in the head, the stage when the irritability of the lining membrane is so great that sneezing is occasioned by the slightest movement of air. It is best combined with morphia and powdered gum arabic as Ferrier's snuff (see p. 155). In 10-grain doses the subnitrate, or still better the carbonate, of bismuth is one of the best remedies in irritable indigestion, of which pain squeamishness and vomiting are the signs. In the beginning of cold in the stomach—gastric catarrh—when everything is rejected, and there is headache, bone-pains, and feverishness, bismuth with opium in the form of Dover's powder commonly acts like a charm. If it is not desirable to give opium, for example to young persons or to those with whom opium disagrees, it may be combined with one of the preparations of lime or magnesia. A solution of bismuth is now obtainable from all chemists, which may be used for children, and the dose of which is from ½ to 1 teaspoonful for adults. The drug is as useful for irritable conditions of the bowel, diarrhœa, dysentery, &c., and specially for the diarrhœa coming on suddenly after a meal.

Dilute Hydrocyanic Acid.—A solution of prussic acid. Pure prussic acid is one of the most powerful poisons, a single drop let fall into the eye, nose, or mouth of a small animal killing it instantly by its action on the heart and breathing through the nervous system. The dilute acid contains 2 per cent by weight of the pure. Poisonous doses paralyse the brain, nerves, and muscles. If the strong acid be applied to the skin it renders the part numb, abolishing in it the sense of touch by passing through the horny layer and paralysing the sensory nerves, and the dilute acid, applied for a time, will produce a like effect. It is this action which renders it a valuable drug for depressing the sensibility of the throat and stomach and allaying irritability. When a dose of the weak acid is taken into the mouth it produces a dulling effect upon the throat and gullet, and a

soothing influence on the stomach. For these purposes the dose of the dilute acid is 2 to 8 drops.

Poisonous doses, not large enough to kill instantly, produce slowness of breathing, difficulty of breathing, symptoms of suffocation, and death, after convulsions, by suffocation, all this owing to paralysis of the nerve-centre presiding over the movements of breathing. Headache, mental confusion, and stupor are also among the symptoms. In cases of accidental poisoning the person must be taken into the cold air, artificial respiration must be used, and sluicing with cold water. Freshly-prepared oxide of iron along with carbonate of soda, potash, magnesia, or lime is an antidote.

Dilute hydrocyanic acid is never prescribed alone, but always in combination with other substances of a sedative kind, such as bismuth, solution of morphia, and so on. Besides in cases of irritable dyspepsia, it is used for dry irritable cough, and to relieve the hacking cough of consumption and the asthmatic cough. It is also employed as a wash, ½ ounce to 8 ounces of rose-water, for itching of the skin, or in combination with zinc ointment—30 to 60 drops to each ounce—for a like purpose.

Among other sedatives to the stomach are—**Belladonna** and its active principal **Atropine**, **Opium** and its active principal **Morphia**, which are discussed in the section devoted to Drugs Acting on the Nervous System.

Oxalate of Cerium is another drug, given in doses of 1 and 2 grains as powder for vomiting, specially the vomiting and heartburn of pregnancy. It is not, however, very reliable.

Chloroform, Ether, and Cocaine, discussed elsewhere, are also gastric sedatives.

Sulphurous Acid, Creasote, Carbolic Acid, in 1-drop doses in water, also allay irritability of stomach when it depends on processes of fermentation set up within the stomach.

Ice and bismuth with the outward application of mustard poultices are the remedies to be commonly employed for allaying stomach irritability, of course after any irritating substance has been expelled, and combined with the administration of bland soothing food, in small quantities.

DRUGS WHICH ACT ON THE BOWELS.

A large portion of what has been written in the previous part of this section is as applicable to the bowel as to the stomach itself. The bowel may be stimulated by the same means which stimulate the stomach, such means as excite a more lively circulation or a more vigorous movement, such as bitter and aromatic tonics. The same remedies which are useful in expelling wind from the stomach will help in dispersing it from the bowel, and the drugs which exert a sedative influence on the one will do so on the other also. Then the whole bowel will be markedly influenced by the state of the stomach. If the contents of the stomach have left it in an irritating, intensely acid, acrid condition, they will prove very irritating also to the small bowel, which they enter; and the acidity may not be sufficiently neutralized to allow of the digestion by the pancreas and the bile to go on satisfactorily. An ill-digested mass will consequently be passed along the bowel, producing irritation as it goes, ending, it may be, in irregular contraction of the bowels, colic, and hasty expulsion of the offending materials by a too copious discharge. This condition of affairs the administration of some alkaline medicine, soda or potash, while the food was still in the stomach, would have greatly diminished, if not prevented, by diminishing the excessive acidity. On the other hand, if, through weakness, the gastric juice has been deficient, the contents of the stomach have not been acid enough, the absence of the usual stimulus of the acid material passing over the openings of the bile and pancreatic ducts might lead to a diminished flow of the respective juices and to a continuance of the imperfect digestion already begun in the stomach. So that we may say the proper performance of digestion in the stomach is the necessary preparation for proper digestion in the upper part of the small intestine. There remain, then, for our consideration, two large classes of drugs affecting the bowel, namely those which assist in the expulsion of the remains of the food and other contents from the bowel, and those which restrain such an action, in short purgatives and astringents, remedies for constipation and for diarrhœa.

Remedies for Constipation: Purgatives, &c.

When one considers on what conditions the regular onward progress of the altered foods in the bowel depends, it becomes easier to understand in how great a variety of ways constipation may be produced and after how many different methods it may be treated. To the altered food as it passes along the bowel, there are added various juices, the bile, pancreatic juice, and intestinal juice, dependent as to quantity upon the blood supply to the organs manufacturing

them, and upon the stimulus received from the food itself. From this mixture of food and digestive juices there is being removed, in liquid form, as it passes along, much of its nutritive material, and the consistence of the mass in its onward progress will depend on the relation between the addition of fluid and the abstraction of dissolved nutriment. Defective secretion and slow progress will produce a very dry residue, little being added and as much as possible abstracted, while hurried progress will make a very fluid residue, because little time is given for absorption; and such hurried progress is usually the result of irritation, which will have, as another of its effects, a more copious secretion. The onward progress is due to the worm-like spiral wave of contraction that passes along the bowel always in one direction—the peristaltic movement, and this movement depends for its rate and its energy upon the excitability of the muscular wall of the bowel and on the state of the nerves between the muscular layers. It remains to be added that the bile, besides aiding the movement merely by its watery character, does so also by the stimulating action it has upon the bowel, increasing thereby the peristaltic contraction. It is plain, therefore, that the movement of the remains of food-stuffs along the digestive canal will be aided by any substance which (1) increases the quantity of the digestive fluids, or (2) drains water from the blood into the canal, or (3) increases specially the quantity of the bile, since it is particularly stimulating, or (4) increases the movement either by directly exciting the muscular walls, or indirectly by acting through the nerves. Now, there are drugs capable of accomplishing one or other of these actions, and some of them act at the same time in several of the ways indicated. Certain terms are employed to signify the special way in which the remedy acts. The general term for all the varieties of action is **purgative**, from Latin *purgo*, I cleanse, since the effect is to clear offensive material from the bowel. **Cathartic** is a term implying the same thing, being derived from the Greek *kathairo*, I purge. When the means used are such as to cause simply a movement of the bowel in the mildest possible way, without producing any marked effect upon secretions or the walls of the bowel, they are said to be **aperient**, from Latin *aperio*, I open, or **laxative**, from *laxo*, I loose. When the action produced is violent, the substance is said to be a **drastic purgative**, from the Greek *drastikos*, active. Now, ordinarily, purgatives act in more ways than one, they both stimulate the walls of the bowel to increased movement and they excite an increased secretion. But there are others which act specially in one direction. For example, substances like common salt, Epsom salts, rochelle salts, &c., all saline medicines, are particularly active in withdrawing water from the blood and producing copious watery stools, and such remedies are technically called **hydragogue cathartics** (from Greek *hudor*, water, and *ago*, I drive out). Again there are purgatives whose special action consists in increasing the flow of bile from the liver, and these are called **cholagogues** (Greek *chole*, bile, and *ago*); such are podophyllin, rhubarb, calomel, and aloes.

Laxatives or Aperients.

Many substances, not necessarily drugs, act in a mild way in aiding movement of the bowels. Foods which have some roughness when prepared, such as oatmeal porridge and bran bread, are suitable for this purpose. Substances also which have a large residue of undigested material help to a movement of the bowels by their mere bulk, such as vegetables and fruits, like prunes, figs, apples, &c., the vegetable acids of which are also agents in the process.

Castor-oil is the chief of laxative medicines. It is the oil expressed from the seeds of the castor-oil plant — *Ricinus communis* — which grows in America and the East Indies. The remains of the seeds, after the oil has been separated, contain a substance which has a violent purgative action. The castor-oil seeds, or beans, if taken themselves, produce severe inflammation of the bowel, shown by violent vomiting, purging, and collapse, even death. The oil contains almost none of the substance to which these effects are due. It is in small doses mild and non-irritating in action, and is, therefore, suitable for women, delicate persons, and children, and is always a useful agent when it is desired to move the bowels with as little disturbance as possible, as in irritable conditions of the bowel, in pregnancy, when piles or fissure of the anus is present, and in other similar circumstances. When taken by a nursing mother, it acts also upon the child through the milk.

In two opposite conditions it is specially valuable: first in that of simple constipation, where one desires simply to empty the bowel, and to produce no other effects, and second in diarrhœa. The type of diarrhœa in which it is specially useful is that dependent upon some irritating material in the bowel, ill-digested

food, for example. The castor-oil sweeps out the offending material, and thus allows the bowel to quiet down. In the diarrhœa of children, therefore, in particular that dependent upon some error in diet, specially apt to occur in summer, is castor-oil valuable.

Dose for adults, $\frac{1}{2}$ to 1 ounce.
,, children, 1 tea-spoonful and upwards.

For constipation it is best given in the morning, an hour before breakfast; given thus early, a small dose often suffices. From 15 drops to half a tea-spoonful may be tried. The spoon or glass in which it is to be dropped should be well wetted with water or peppermint water. Indeed, if a little peppermint water be taken in the vessel first, and the oil dropped upon it, the glass being kept in gentle motion to keep the sides wet and free from the oil, the oil may be swallowed down floating on the water, and leaving no taste. Lemon-juice, coffee, and milk are used on which to float the dose, or an equal quantity of glycerine may be added to the dose, and a drop or two of oil of cinnamon. Castor-oil is recommended to relieve painter's or lead colic. In threatened inflammation of windpipe and in bronchitis a dose affords much relief. It may be dropped into the eye to relieve the feeling of sand in the eye, and in cases of accidental burning of the eye. The leaves of the castor-oil plant have been used as a poultice to the breast to encourage the flow of milk.

Senna is also a much-used laxative medicine. It is the leaves of small shrubs belonging to the genus *Cassia*. There are several kinds, one Egyptian—Alexandrian senna, another Indian —Tinnevelly senna.

The preparations of senna are as follows:—

Infusion of Senna, (Senna leaves 1 oz., sliced ginger 30 grs., boiling water 10 ozs.; infuse one hour and strain.)	Dose, 2 to 4 table-spoonfuls.
Syrup of Senna,	,, $\frac{1}{2}$ to 4 tea-spoonfuls.
Confection of Senna contains, besides senna in powder, coriander, figs, tamarind, cassia pulp, prunes, extract of liquorice,	,, 60 to 120 grains.
Tincture of Senna,	,, 1 to 4 tea-spoonfuls.
Black Draught, or Compound Mixture of Senna, (Epsom salts 4 ozs., extract of liquorice $\frac{1}{2}$ oz., tincture of senna, $2\frac{1}{2}$ ozs., compound tincture of cardamoms $1\frac{1}{4}$ oz., infusion of senna enough to make up a pint.)	,, 2 to 3 table-spoonfuls.
Compound Liquorice Powder, made of 1 oz. powdered liquorice root, 1 oz. of senna, and 3 ozs. of sugar,	,, 30 to 60 grains.

Senna acts briskly on the bowel, increasing both the movement and the secretion from the walls of the bowel. It acts chiefly on the small intestine, and not on the large intestine. This contrasts it with aloes, which acts principally on the large bowel. It is apt to cause sickness and griping, but this is avoided by combining it with other drugs, such as Epsom salts, and as illustrated in the compound senna mixture. Senna taken by a nursing mother will affect the child. It should not be given when any irritability of bowel is present. The syrup is a pleasant opening medicine for children; and the compound liquorice powder is very largely used for simple constipation.

Sulphur also belongs to the laxative group of medicines, because of its stimulating effects on the wall of the bowel. The preparations and other uses of sulphur and its compounds are stated at length on p. 826. For the laxative effect the old-fashioned sulphur electuary is the best form for administration.

Tamarind.—The preserved pulp of the fruit of the Indian tamarind is a pleasant and effective medicine. The *Tamarindus indica* is a tree 60 to 80 feet high, indigenous to India and tropical Africa, belonging to the natural order Leguminosæ, the same order as the pea and bean. The fruit is a pod about 6 inches long and 1 inch broad, containing an acid pulp, in which the seeds, nine to ten in each pod, are embedded. The West Indian fruit is shorter in pod. The pod is inclosed within a thin pale-brown shell, which is removed for purposes of preservation, and then the soft pods are pressed into a mass, to which sugar is sometimes added. In Upper Egypt the soft pulpy mass is formed into cakes, and dried in the sun; in the West Indies hot syrup is poured over the pods. From the fresh leaves and flowers of the tamarind cooling acid drinks are prepared.

Tamarinds contain citric, tartaric, and malic acids to the extent of over 10 per cent, also cream of tartar is present to the extent of $3\frac{1}{4}$ per cent, and nearly 24 per cent of sugar, gum, and pectin. Woody fibre forms over 34 per cent, and water $27\frac{1}{2}$ per cent.

Purified tamarind pulp is prepared by making a semi-liquid mass of East Indian tamarinds with boiling water, passing the whole through

a hair sieve, and then evaporating the fine pulp obtained to a proper thickness and adding a fifth of its bulk of powdered sugar. The prepared pulp is employed in the making of confection of senna.

Tamar Indien is a kind of laxative sweetmeat. It consists of compressed tablets of tamarind pulp to which some purgative has been added, perhaps senna or jalap, and which is flavoured with other materials.

The quantity of tamarinds necessary for laxative effect is ¼ oz.

Besides being laxative, tamarind, because of the acids and cream of tartar it contains, is useful for diminishing thirst, is cooling, and useful in feverish conditions. For drinking purposes **tamarind whey** is the form of employment. It is prepared by boiling 1 oz. of tamarind pulp with a pint of milk and then straining and filtering, and a simpler drink may be made by adding 4 ozs. of tamarinds to 100 ozs. of boiling water, straining, filtering, and allowing to cool.

Buckthorn is another mild opening medicine in common use as a syrup. The buckthorn is a branching shrub about 9 feet high, growing in thickets in Europe and Siberia, native to Britain, and cultivated to some extent for hedges in North America. It belongs to the natural order Rhamnaceæ. There are several allied plants employed as laxatives in medicine, all of which may be noted here. The **common buckthorn** is *Rhamnus catharticus.* The ripe berries are employed to yield a juice—Buckthorn juice, which is used only in the manufacture of the syrup of buckthorn. There is the **alder buckthorn** or black alder, a shrub 10 to 15 feet high, the proper name of which is *Rhamnus Frangula.* The dried bark, frangula bark, is employed as a domestic purgative in Germany. A decoction of it is prepared with ½ oz. of bark and ½ pint of water and given in table-spoonful doses. There is a recognized extract of frangula bark and a liquid extract. The bark should be kept at least a year before being used; when it is fresh it has too irritating properties.

A third kind of allied plant is the *Rhamnus Purshiana* found on the Pacific slopes of North America. It is a small tree, 15 to 20 feet high. The bark is used to yield an extract. On the Pacific coast it is called **Chittem-bark**, and is now more commonly known as **Cascara Sagrada**, or sacred bark.

The commonly used preparations of these varieties of the buckthorn species are as follows:—

	DOSE.
Syrup of Buckthorn, ...	½ to 4 tea-spoonfuls.
Fluid Extract of Frangula Bark,	1 tea-spoonful.
Extract of Frangula Bark,.....	15 to 60 grains.
Liquid Extract of Cascara Sagrada, ...	10 to 60 drops.

Uses.—Syrup of buckthorn is much used as a domestic remedy for children. It acts quickly but is apt to be accompanied with some griping. The liquid extract of cascara sagrada is, however, very extensively used in cases of habitual constipation, not as a purgative, but simply to secure no more than a natural motion. For this purpose the person troubled with habitual constipation should find the dose that is just sufficient to secure an ordinary motion. He should begin with 30 drops, which may be taken flavoured in any way he pleases. If that is not enough, a tea-spoonful may be tried; if it on the contrary acts too strongly, 15 drops may be sufficient. But let the exact quantity be determined, and then let that quantity be taken regularly once a day, at bed-time or on rising in the morning. A smaller dose is likely to be sufficient, if taken in the morning on an empty stomach, but some people prefer to take the medicine at bed-time, and it is then likely to act after breakfast, and so inconvenience during the day is avoided. After taking the drug regularly in this way, each day for a fortnight or three weeks securing a regular motion, the effort may now be made to diminish the medicine. It is still to be taken daily with perfect regularity but in gradually diminishing doses. Thus, if 15 drops have proved sufficient, 14 drops may be taken. If it is still sufficient, after several days 13 drops may be used, and so on. For with habitual use of cascara sagrada, unlike ordinary purgative medicine, a tonic effect on the bowel is produced, and smaller doses begin to have the required influence. In time the constipation may thus be completely relieved, and the use of medicine discontinued.

Dandelion Root.—The fresh and dried roots of *Taraxacum Dens Leonis* gathered between September and February from meadows and pastures in Britain. Its preparations are:—

Decoction of Dandelion,	Dose,	2 to 4 ounces.
Extract of Dandelion, ..	,,	5 to 15 grains.
Dandelion Juice, ...	,,	2 to 4 tea-spoonfuls.

Uses.—Dandelion was believed to stimulate the flow of bile directly. It appears, however, that it promotes the flow of bile only by its slightly opening effect, and that its chief value is as a tonic and mild laxative. It may be given in cases of habitual constipation and weak

digestion, and is usefully combined with the dilute nitro-hydrochloric acid when liver symptoms are prominent. It sometimes acts upon the kidneys.

Other drugs used as laxatives are:—

Glycerine in a dose of 1 to 2 tea-spoonfuls.
Light and Heavy and Carbonate of Magnesia (see p. 843).
Manna (see p. 590).
Olive-oil, ... Dose, 1 to 2 tea-spoonfuls.
Almond-oil, ... ,, ,, ,,

Simple Purgatives.

These are substances which act more strongly than the mere aperients or laxatives, owing to a more pronouncedly irritating effect upon the walls of the bowel. On this account they are likely to be attended with some amount of griping, and they produce more liquid stools, acting, it may be, more than once. Some of the drugs already named under the laxatives act as simple purgatives if given in larger doses, such as senna, buckthorn, and castor-oil. The chief of the simple purgatives are rhubarb and aloes.

Rhubarb is the dried root of a plant obtained in China, Chinese Tartary and Thibet, and imported from Shanghai and Canton. It was known as a purgative in China from time immemorial, the earliest accounts of it coming through Arabian writers. Its name is derived from that of the river Rhâ—the Volga—from which direction it came to the countries bordering the Levant. Its chief preparations are as follows:—

	DOSE.
Tincture of Rhubarb, ...	1 to 8 tea-spoonfuls.
Wine of Rhubarb, ...	1 to 2 ,,
Syrup of Rhubarb, ...	1 to 4 ,,
Powdered Rhubarb Root, ...	10 to 30 grains.
Gregory's Powder (Compound Rhubarb Powder), ..	30 to 60 ,,

(Powdered rhubarb root 2 ozs., light magnesia 6 ozs., ginger 1 oz.)

Compound Rhubarb Pill, ... 1 to 2 pills, 5 grains in each.

(Contains rhubarb, aloes, myrrh, hard soap, oil of peppermint, and treacle.)

Uses.—The stimulating effect of rhubarb is experienced if a piece of the root be chewed in the mouth; it promotes the flow of saliva owing to the bitter principle it contains. It has a similar effect on the stomach, if taken in a small dose, acting, therefore, as a slight tonic to the stomach. Rhubarb contains a form of tannic acid, and, therefore, in small doses a slight astringent effect is produced. By larger doses the bowel movement is much increased, and a purgative action results, the flow of bile being also increased. After the contents of the bowel have thus been expelled, the tannic acid comes into play, and a binding effect is produced. Rhubarb is therefore, a very popular and useful remedy in cases of diarrhœa, due to the presence of some irritating material in the bowel, especially in children, for its first effect is to expel the irritant, and its later effect is to restrain the diarrhœa. For children it is commonly and rightly associated with magnesia for this purpose. The presence of piles is another condition in which rhubarb is useful, since it not only opens the bowels but exercises a tonic influence on the lining membrane of the bowel.

The doses named above are chiefly purgative doses. If tonic and astringent effects only are desired, less quantities, about half those named, would be employed.

Aloes is the dried juice of several varieties of the Aloe, belonging to the lily order of plants. There is the Socotrine aloes, derived from plants grown chiefly in Socotra and imported by way of Bombay, the Barbadoes aloes from the *Aloe vulgaris*, and Cape aloes.

Its preparations are as follows:—

	DOSE.
Barbadoes or other kind of Aloes in powder, ...	2 to 6 grains.
Tincture of Aloes (from Socotrine Aloe), ...	1 to 2 tea-spoonfuls.
Wine of Aloes ,, ,, ...	1 to 2 ,,
Compound Decoction of Socotrine Aloes, ...	2 tea-spoonfuls to 4 table-spoonfuls.
Extract of Aloes (from Socotrine Aloe), ...	1 to 3 grains.
Extract of Aloes (from Barbadoes Aloe), ...	½ to 2 ,,
Pill of Aloes (both kinds of Aloe), ...	1 to 2 pills of 5 grains each.
Pill of Aloes and Iron contains Barbadoes aloes, sulphate of iron, with compound cinnamon powder and confection of roses, ...	1 to 2 pills of 5 grains each.
Pill of Aloes and Myrrh contains Socotrine aloes, myrrh, saffron, and confection of roses, ...	1 to 2 pills of 5 grains each.
Pill of Aloes and Assafœtida contains Socotrine aloes, assafœtida, hard soap, and confection of roses, ...	1 to 2 pills of 5 grains each.
Aloin, ...	¼ to 2 grains.

Uses.—All varieties of aloes contain a bitter principle, **aloin**, which can be separated out in small colourless needle-shaped crystals, to which the effects of the aloes are due. Its chief effect is to stimulate the movements specially of the lower end of the large bowel. Influencing

mainly the termination of the bowel, its action is slow, so that it produces no effect for ten, fifteen, or even twenty-four hours after its administration, when it produces a large soft stool, with little griping, unless a large dose has been given, when pain and severe straining and even bleeding from the bowel may result. If it is given in large doses, the great irritation produced is not confined to the lower end of the bowel but affects neighbouring organs, and specially in women the womb. It stimulates also the secretion of the intestinal fluid, and it stimulates the liver, increasing the flow of bile. Indeed the presence of bile is necessary for its purgative action, and consequently in cases of illness, where there is absence of bile, if aloes is to be administered it is combined with purified ox-gall. These facts indicate very clearly the conditions in which aloes is a desirable purgative to employ, and also under what circumstances one ought to be chary of giving it.

If habitual constipation seems to be the result of weakness of the large bowel, the motions accumulating in the rectum, it is the proper purgative to use, *provided piles or other irritable condition does not exist.* It is improper to give it to women during pregnancy, from the risk of the irritation leading to abortion. But this very reason is one which indicates its usefulness in certain conditions of the womb associated with constipation. In absence of the monthly discharge it is given, combined with iron or myrrh, about the time the illness is expected, in order to stimulate its occurrence. One advantage of aloes in habitual constipation is that its use does not tend to make the constipation all the worse after its action. Increasing doses are not required as with most other purgatives, but rather the reverse. Owing to its slowness of action it is well to give aloes as a dinner pill, that is just before dinner, and it may then be expected to act next morning after breakfast. The most useful form of administration is aloin, given in pill in combination with other drugs to check any griping action. An excellent pill of this description is prepared by Schieffelin, of New York, of aloin, belladonna and strychnine, and to be had in the larger towns all over the world. They are very small and tasteless, but effective. The compound decoction is an excellent preparation, and useful in the constipation of children, when the motions are very hard, and accompanied by general digestive derangement.

Stronger Purgatives or Cathartics.

Cathartics, as already explained, are drugs which purge, but the term is usually applied to those which act more markedly than the simple purgatives already named. This they do by specially acting on the glands of the mucous membrane of the bowel, increasing the amount of fluid poured out, and producing watery stools. At the same time they also excite increased peristaltic movement of the bowel, and thus promote rapid expulsion of the contents. The chief of these are colocynth, scammony, and jalap.

Colocynth, as used in medicine, is the dried fruit, freed from rind and seed, the pulp, that is to say, of the *Citrullus colocynthis*, belonging to the cucumber order, and imported from Smyrna, Trieste, France, and Spain. Its dose and preparations are:—

Powdered Colocynth,	Dose, 2 to 8 grains.
Compound Extract of Colocynth contains colocynth, aloes, scammony, soap, and cardamoms,	,, 3 to 10 ,,
Compound Colocynth Pill (Gregory's Pill) contains colocynth, aloes, scammony, sulphate of potash, and oil of cloves,	,, 1 to 2 pills of 5 grains each.
Compound Colocynth and Henbane (or Hyoscyamus) **Pill** is the same as the compound colocynth pill, with the addition of a little extract of hyoscyamus to diminish pain and griping,	,, 1 to 2 ,, ,,

Uses.—Colocynth acts as a strong stimulant to the stomach and bowel, and after large doses the action becomes powerfully irritant, large quantities of fluid being poured into the bowel; in short, a catarrh is produced, just as irritation of the nostrils will cause a flow from them. At the same time the movement of the bowel is increased, so that griping pains are felt and the contents of the bowel are hurried on to the outlet. It does not matter whether the drug is taken by the mouth, injected up into the bowel, or whether the active principle it contains—colocynthin—is injected under the skin, the same results follow. The liver is also stimulated, and an increase in the outflow of bile excited. In large doses it acts as a drastic purgative, and would occasion in too large doses inflammatory symptoms. It is a useful medicine in obstinate constipation given with other drugs to aid or correct its action, such as in the compound pill. The compound pill with henbane is more agreeable, because the latter drug diminishes the

griping tendency. The purgative action is followed, however, by constipation, and this is a disadvantage. It is, nevertheless, a very useful pill for stout, full-blooded people, on any threat of excess of blood to the head, and in any case where quick relief to the liver and bowels is desired; but it ought not to be given to delicate persons, or any subject to bowel irritation.

Scammony is a plant belonging to the convolvulus order—*Convolvulus scammonia*—growing in Syria and Asia Minor. The dried root is used in medicine. From the fresh root a milky juice is obtained by cutting. This is mixed with juice scraped from the root, and is dried, forming the scammony of commerce. From this the pure resin of scammony is obtained by solution with spirit and precipitation in water.

Powdered Scammony,	Dose, 5 to 10 grains.
Resin of Scammony,	,, 3 to 8 ,,
Confection of Scammony,	,, 10 to 30 ,,
Compound Powder of Scammony, (Scammony powder 4 ozs., jalap 3 ozs., ginger 1 oz.)	,, 10 to 20 ,,
Scammony Mixture, (4 grains resin of scammony rubbed up with 2 ozs. fresh milk.)	,, ½ to 1 ounce for a child.
Compound Scammony Pill contains resin of scammony and of jalap, curd soap, and tincture of ginger,	,, 1 to 3 pills of 5 grains each.

Scammony is contained in the compound colocynth pills.

Uses.—This drug is a powerful purgative, owing to the presence of a substance called **jalapin**, promoting the expulsion of large watery stools, and increasing the flow of bile from the liver. It is not a reliable drug when given alone. It has no marked taste, and has, therefore, been used for children in the form of scammony mixture. It is used not only for constipation, but to expel tapeworm, but ought not to be used for delicate children.

Jalap is the dried tubercles from the root of a plant, the *Exogonium Purga*, found in the woods of the Mexican Andes. It is also cultivated in the Indian Nilgherry Mountains. The root is reduced to powder. From the root a resin is obtained by means of spirit. The chief preparations are as follows:—

	DOSE.
Powdered Jalap,	10 to 30 grains.
Resin of Jalap,	2 to 5 ,,
Tincture of Jalap,	½ to 2 tea-spoonfuls.
Compound Powder of Jalap contains powdered jalap 5 ozs., cream of tartar 9 ozs., ginger 1 oz.,	20 to 60 grains.

Uses.—Jalap and scammony resemble one another in containing an active principle, which is similar in both. That of jalap is called **convolvulin**, that of scammony **jalapin.** Jalap is less irritating and less likely to gripe. It increases slightly the flow of bile from the liver, but produces a most copious flow of watery fluid from the intestinal glands. It is because of this marked property of removing water that it is used in dropsies. The compound powder is the best for this purpose, owing to the presence of the cream of tartar, and when it is desired quickly to unload the liver, as in cases of congestion of the brain, it is combined with calomel, 5 grains of the latter and 15 or more of jalap, a grain or two of ginger being added to diminish pain. It will thus act in a couple of hours.

Drastic Purgatives.

Drastic purgatives are drugs which excite violent action of the bowels, producing a copious flow of fluid by irritation and increased activity of the bowel walls, the irritation passing into inflammatory action if the doses be large. Some of the drugs already considered act thus if given in excessive doses, such as colocynth, scammony, and jalap; and podophyllin, to be considered under drugs which promote the flow of bile, acts similarly if given freely enough. Such drugs are only employed either when it is necessary, even at the risk of great irritation of the bowels, to withdraw blood quickly from the head, as in threatened congestion or apoplexy, or when one seeks to remove dropsical fluid. They are too harsh remedies to be employed except by skilled persons, and then with great caution.

Elaterium is the most violent of drastic purgatives. It is the sediment from the juice of the ripe fruit of a plant belonging to the cucumber order, the *ecbalium* or *squirting cucumber.* Its dose is $\frac{1}{16}$th grain. A compound powder is made of 1 grain of elaterium and 9 of sugar of milk, of which the dose is ½ to 5 grains. The active principle of elaterium is **elaterin,** of which even $\frac{1}{40}$th grain is effectual.

Use.—Elaterium is employed to produce frequent watery motions, specially in cases of dropsy dependent upon heart-disease.

Croton-oil, Tiglium-oil, is another drastic purgative. It is an oil expressed from the seeds

of *Croton Tiglium*, of the natural order Euphorbiaceæ, found in some of the East Indian and Philippine Islands. It has been used from time immemorial in Hindostan as a purgative, though only introduced into Europe in 1820. Its dose is ½d to 1 drop mixed with olive oil, or made into a pill with bread crumbs. A liniment is made with oil of cajuput.

Uses.—Croton-oil is a powerful irritant, whether applied externally or taken internally. It is employed as a liniment to produce inflammation of the skin and the formation of pustules, as one might use a blister, for the sake of reducing inflammation in deeper structures. It used to be employed over joints in cases of inflammation, and on the chest in cases of lung affection, but is not now much employed. The pustules produced are slow to heal and leave unsightly scars. Internally, its irritating effects are experienced as a burning sensation in the throat and stomach, as sickness, perhaps, and speedy purging. Several motions follow the first, more liquid than it. It is seldom resorted to, even in obstinate constipation; but its speedy action—it purges in 1 or 2 hours—is sometimes sought in cases of apoplexy, shock, unconsciousness, where one desires to withdraw blood from the head, and where, because of its small dose, it can be easily administered even to an unconscious person. The dose is simply placed on the back of the tongue.

Gamboge, gum resin obtained from a tree indigenous to Siam, the *Garcinia Morella*. It is a drastic purgative, acting like colocynth, producing watery stools, but is never used alone, and seldom, indeed, at all. A compound pill contains aloes along with gamboge. It will expel worms from the intestine. Its dose is 1 to 4 grains.

Saline Purgatives.

To this class of purgative medicines belong the most commonly used medicines—Epsom salts, seidlitz powder, Rochelle salts, cream of tartar, &c. The chief cause of their purgative action seems to be dependent upon physical laws. On p. 134 the physical process called osmosis has been described. If two fluids containing some salts in solution be separated from one another by an organic membrane, an interchange will occur between the two fluids through the membrane until the fluid on both sides of the membrane come to be alike in the quantities of salts they have in solution. If, for example, on one side of the membrane is water containing much common salt in solution and the fluid on the other side contains less, water will pass through the membrane to dilute the strong solution. If a liquid be swallowed, then in the stomach there is a state of things such as has been suggested. In the stomach is a liquid; flowing in the blood-vessels of the walls of the stomach is another liquid, the blood; these two fluids are separated by an animal membrane, the walls of the blood-vessels; if the two fluids differ from one another in density then an exchange will occur between the blood and the contents of the stomach. Suppose pure spring water has been drunk. It will speedily pass into the blood, diluting it, and the water will then be separated out by the kidney. If the water contain a large quantity of dissolved salts, then water will pass from the blood into the stomach to dilute it, and the bowel will contain a large quantity of fluid material. This is at least a large portion of the mode of action of these saline substances. Doubtless they not only drain water from the blood by this physical process, but also excite the glands, and to some extent increase the movement of the bowel. Sometimes, however, the saline medicine produces little increase of the wave-like movement of the bowel. This explains what sometimes occurs after taking a seidlitz powder. The person feels oppressed with the quantity drank, and the feeling of loaded bowels increases rather than diminishes, but no purging occurs. The powder has acted as explained, and a large quantity of liquid accumulates in the bowel, but for want of stimulus to the wave-like motion of the bowel—peristaltic movement—the fluid is not swept onward. It is gradually reabsorbed and passed back into the blood, and no motion results. To avoid this it is well to combine some simple purgative with the saline draught. Thus a purgative pill is taken at night and a seidlitz powder in the morning; that is to say, when it is about time for the pill to produce increased action of the bowel the seidlitz powder causes a flow of fluid to the bowel, which is then swept onward. The old black draught—syrup of senna and a solution of Epsom salts—is an illustration of the same thing.

Epsom Salts are the sulphate of magnesia. They produce watery stools, but excite the movement of the bowel very little, and may be usefully combined with senna or cascara sagrada (see p. 858). To secure by a single dose purgative action, ½ to 1½ ounces are needful; if taken in repeated doses, 1 to 2 tea-spoonfuls are sufficient each time. About a third of a tea-spoonful in water will act upon the kidneys

rather than the bowels if the skin be cool, but will help to cause sweating if the skin be kept warm. A full dose is very useful in feverish conditions, and repeated small doses are advised for biliousness. The early morning is the best time for taking this as well as other saline medicines.

Cream of Tartar, the acid tartrate of potash, has already been mentioned in considering the potash salts (p. 818). If given in doses of from 2 to 8 tea-spoonfuls it acts as a purgative, copious watery stools resulting; if given in doses of from ⅓ to 1 tea-spoonful it acts upon the kidney, increasing the quantity of urine; or, if the body be kept warm, upon the skin, increasing the sweat. Thus an excellent cooling drink—the imperial drink—is made with 1 or 1½ tea-spoonful of cream of tartar, a little sugar, 1 pint of boiling water, and half the peel of a fresh lemon. When used as a purgative it is in combination with jalap or scammony, and usually to remove dropsical fluid.

The tartrate of potash (dose: ¼ to ½ oz.) and the sulphate of potash (dose: 15 to 60 grains) are also used as purgatives, and the general remarks already made at the head of this paragraph apply to them.

Rochelle Salts are the tartrate of soda and potash or tartarated soda. They act like other saline purgatives, but excite the peristaltic movement of the bowel more than Epsom salts. In ¼ to ½ ounce doses this is their effect; in small doses, ½ to 1 tea-spoonful, they increase the flow of water from the kidney.

Seidlitz Powder is a mixture of Rochelle salts and bicarbonate of soda in fine powder, 120 grains of the former and 40 grains of the latter. It is employed for such purposes as have been mentioned in speaking of Epsom salts. It is commonly employed as an effervescing drink. To produce the effervescence the addition of tartaric acid in fine powder to the seidlitz powder, when dissolved in water, is necessary. The seidlitz powders of the shops, therefore, contain the seidlitz mixture in one paper, and in a second paper 37 grains of powdered tartaric acid. The double-strong seidlitz powder contains, in the paper holding the seidlitz mixture, an additional quantity of Rochelle salts to the amount of 160 grains.

Glauber's Salt is the sulphate of soda, of which the dose is from ¼ to 1 oz. It purges by increasing the flow of watery fluid, but also excites the movements of the stomach and bowels. It is a constituent of Carlsbad, Friedrichshall, Hunyadi Janos, and Bilin mineral waters. It is specially useful in cases of torpid liver and habitual constipation, and in ulceration and dilatation of the stomach, and should be taken in the morning. It is best taken in the form of the crystallized Carlsbad salts, of which ⅓ tea-spoonful should be taken in a large tumblerful of warm water immediately on rising.

Phosphate of Soda is a useful purgative for children, as it has little taste and acts gently. It is given in milk or food to the amount of from 3 to 10 grains, and its use is indicated by the occurrence of green or white stools. For adults the dose is ¼ to 1 ounce.

The Fruit Salts which, on the initiation of Eno, have become so widely used, are combinations of Epsom salts, bicarbonate of soda, tartaric acid, white sugar, or similar preparations. As mild purgatives they are very useful, and may be used as cooling and refreshing drinks.

Purgatives which Increase the Flow of Bile.

It has been noted regarding several of the drugs already mentioned that they stimulate the liver and promote the secretion of bile, notably rhubarb, aloes, colocynth, scammony, jalap. Phosphate of soda, Glauber's salt, Rochelle salts, and other substances have also a similar, though less marked, effect. In the meantime, however, we need to notice here only a few purgative drugs which markedly affect the outpour of bile from the liver, leaving to another place (p. 874) to notice other medicines which stimulate the liver without acting as purgatives. The drugs to be noted are podophyllin, euonymin, and iridin, &c. Calomel and other mercurial preparations, such as grey powder, blue pill, &c., have held long a high reputation for acting on the liver. It would appear that they do not stimulate the liver nearly to such an extent as podophyllin and other drugs. What they do accomplish, however, is a thorough sweeping of the bowel of its contents. How this acts in relieving the liver can be briefly explained. When the bile is poured into the bowel, just at the commencement of its course, it is mixed with the food, aiding its digestion and absorption into the circulation. Much of the bile is reabsorbed along with the nutritive portion of the food, and is passed back into the liver, and only a fraction of it is ultimately expelled from the bowel in the motion. The slower the movement of the food along the bowel the greater will be the amount of reabsorption, and the

less bile will be expelled from the body. On the other hand, anything which quickens the intestinal movement, anything which hurries the food along the bowel to the outlet, will secure the expulsion of a greater quantity of bile from the body by permitting less time for its reabsorption. It is in virtue of this action that calomel and other drugs have gained their repute for biliousness, relieving the liver, and so on. They so stimulate the bowel movements that the bile poured into the bowel is hurried along with the food, and appears in the loose motions, no time being allowed for its being picked up and passed back to the liver. Thus the bowels are cleared out, the liver is prevented receiving back much material it otherwise would have had returned to it, water is drained from blood-vessels supplying the liver, and that organ is at once greatly relieved and also stimulated, because the liver cells are excited to produce more bile to make up for that which has been lost by the action of the medicine. This explanation will also make it clear how prolonged constipation occasions such a feeling of weight, languor, drowsiness, headache, and produces a sallow dirty complexion. People say this is biliousness, but the biliousness is the effect, not the cause. The sluggish state of the bowel permits the motions to remain long before expulsion, allows time for reabsorption of much of the bile, and the liver is oppressed, not because it itself is to blame, but because an outlet is denied to the bile it produces, which is always being returned to it. Under these circumstances, any medicine which will open the bowel and will quickly sweep out its contents will afford immediate and great relief, even although the liver is only indirectly and but slightly stimulated. To this extent, then, every medicine which acts as a brisk purgative will stimulate or at least relieve the liver, by causing a greater quantity of bile than usual to be expelled altogether from the body. The drugs we have now to consider act directly upon the liver cells, creating an increased *production* of bile by their stimulating effects upon the liver substance, while they also excite the bowel to its speedy expulsion.

Podophyllum is the dried root-stock and rootlets of the *Podophyllum peltatum*, or American **May Apple**, called also **Mandrake** in the United States, where it grows plentifully in rich woodlands. It belongs to the order Berberidaceæ. From this a resin is obtained by means of rectified spirit, called resin of podophyllum or podophyllin.

	DOSE
Powdered Podophyllum, ...	10 to 20 grains.
Podophyllin (the resin), ...	½ to 1 grain.
Tincture of Podophyllin, ...	15 to 60 drops.

Uses.—Podophyllin is a powerful purgative, increasing the secretion from the bowel and from the liver, and it thus acts even when injected into the blood. Thus also the resin applied to an ulcer or open wound will produce similar effects along with sickness. It is irritating even to the sound skin, and very irritating to the delicate membrane of eyes, nose, throat, &c., as experienced by workmen engaged in pounding the root. It is a powerful stimulant of the liver, and is particularly useful in the treatment of torpor of the liver, such as is so frequent in persons of a full habit, who live well, and take insufficient exercise, and in cases of bilious headache. Its action upon the bowel, though marked, is, in moderate doses, not very rapid. Its dose can be so regulated that only a single gentle but full motion occurs, but if larger doses be given it purges several times, the stools being very liquid. It does not tend, after moving the bowels, to induce subsequent constipation, and may therefore be used regularly for a long time for habitual constipation. Its tendency to gripe makes it desirable to combine its action with that of other drugs. A good form of administration is—

Resin of Podophyllin, ...	⅛ grain.
Extract of Belladonna, ...	⅛ ,,
Extract of Hyoscyamus, ...	1 ,,
Extract of Nux vomica, ...	¼ ,,

Make into 1 pill.

One of these pills may be taken daily either at bed-time or just on rising, and before any food has been taken. It may be employed for children suffering from habitual constipation, and for them a solution of ¾ grain of podophyllin in 100 drops of rectified spirit is recommended. Of this solution a child may receive from 2 to 10 drops in a tea-spoonful of syrup.

Euonymin is a comparatively recent addition to the list of drugs which stimulate the secretion of bile, while at the same time acting as a purgative like rhubarb or colocynth. It is the active principle of a bark, the bark of the *Euonymus atropurpureus*, belonging to the natural order Celastraceæ, a shrub 6 to 10 or even 14 feet high, found in shady woods of the northern and middle section of the United States of America, east of the Mississippi. It is also called the Wahoo, spindle-tree, or burning bush. The active principle euonymin is

obtained from a concentrated tincture of the bark by precipitating with water.

Euonymin,	Dose, ½ to 5 grains.	
Best given in pill with 1 grain extract of hyoscyamus.		
Tincture of Euonymus (made with 1 oz. of euonymus bark and 4 ozs. rectified spirit),	,,	10 to 40 drops.
Extract of Euonymus,	,,	2 to 5 grains.

Euonymin is given in the same circumstances which indicate the need of podophyllin—bilious headache, sluggish liver, constipation. A decoction may be prepared from the bark itself, 1 oz. of bark to 1 pint hot water, infused for half an hour and strained; of this a wine-glassful is a dose. It is advised to take euonymin at bedtime, and to take a saline purge in the morning, sulphate of soda (see p. 863) being the best.

Iridin is a powdered extractive derived from the rootlets of the blue flag or water-flag, *Iris versicolor*, "common in wet and swampy meadows from Canada southward to Florida, and westward to Minnesota and Arkansas." In the United States the following preparations are used:—

	DOSE.
Extract of Iris,	1 to 5 grains.
Fluid Extract of Iris,	5 to 60 drops.
Iridin,	1 to 5 grains.

It is used in the same circumstances as podophyllin and euonymin, and has similar effects. It may be given in pill like euonymin, with hyoscyamus to prevent griping.

Hydrastis.—Golden Seal, Yellow Root, Yellow Puccoon, Orange Root, Indian Dye, Indian Turmeric, are all names for the same plant, *Hydrastis canadensis*, belonging to the Ranunculus order, indigenous to Canada and the United States. It is used in the following forms:—

	DOSE.
Powdered Root,	10 to 30 grains.
Hydrastin,	½ to 5 grains in pill.
Tincture of Hydrastis,	30 to 60 drops.
Fluid Extract of Hydrastis,	1 to 2 tea-spoonfuls.

Use.—This drug is said not only to be a valuable remedy for habitual constipation dependent upon inaction of the liver, but to be also a good tonic to the stomach, and one of the best remedies for the stomach catarrh consequent upon chronic drinking, and probably the best substitute for alcoholic stimulants when their use has to be abandoned. It is also said to be very useful as a lotion in inflammation of the eyelids, as an injection in discharges from the ear, the genital passages, &c. For such purposes two tea-spoonfuls of the tincture to a pint of water may be employed.

Leptandrin, an active principle obtained from the rootlets of *Leptandra virginica* or Culver's-root, Culver's Physic, Black-root, **Baptisin,** derived from the roots of the *Baptisia tinctoria* or Wild Indigo, **Juglandin,** the powdered extractive from the inner bark of the root of *Juglans cinerea*, or Butternut, **Phytolaccin,** the powdered extractive obtained from *Phytolacca decandra*, or Poke-root—all of the plants being indigenous to the United States—are substances which have effects similar to podophyllin in stimulating the liver and bowels. Their doses are as follows:—

	DOSE.
Leptandrin,	½ to 2 grains in pill.
Fluid Extract of Leptandra,	30 to 60 drops.
Juglandin,	2 to 5 grains in pill.
Extract of Juglans,	20 to 30 grains.
Phytolaccin,	1 to 5 grains in pill.

It may be noted regarding juglandin that allied plants to the *Juglans cinerea*, notably the English walnut (*Juglans regia*) and the black walnut, have also been used for medicinal purposes, decoctions or poultices made from the leaves being popularly used for the treatment of sores, and ulcers of all parts, and discharges of all kinds. The decoction, tincture, and juice of the leaves of Phytolacca have been used for similar purposes, and for various skin eruptions, such as ringworm, itch, and mange in dogs. Phytolacca has also a popular reputation for relieving the pains of rheumatism and procuring sleep. It is used in these cases as a tincture of the root or the berries, or a decoction of the root.

Remarks on the Use of Purgatives.—Opening medicines must never be given without due regard to the age and condition of the person. The young and the aged, as well as those of all ages and both sexes who are delicate, or reduced by disease, ought not to have strong opening medicines. The mildest of laxatives ought to be employed, and that after an endeavour has been made rather to regulate the bowels by proper diet. The simplest aperient is castor-oil, and sulphur and senna are also mild in action. In many such cases an injection is preferable to medicine by the mouth. The saline purgatives may be given, but they ought to be warmed, and probably the best will be found in one of the mineral waters, Hunyadi Janos, Carlsbad, or Friedrichshall. Then again caution ought to be displayed in administering purgative medicines to any suffering from irritable or ulcerated conditions of the bowel, or from piles

or fissure of the anus, or in cases of pregnancy, or during the monthly illness. Again, it must be remembered that the frequent use of purgatives rather confirms than diminishes a tendency to constipation, and a drug ought, if possible, to be selected which has not this disadvantage. This is the objection to the use of the commonly employed pills, colocynth, &c. It has been pointed out that this disadvantage is got rid of by the use of cascara sagrada, and is not a feature of aloes or podophyllin. Then an endeavour to note the chief feature of the constipation will aid in selecting the drug. If large, hard, dry motions are passed, the indication is that the remains of the food pass too slowly along the bowel, so that too much fluid is removed from them. This aloes would probably aid, or podophyllin, or rhubarb, or senna in the form of compound liquorice powder, or a morning draught of saline medicine. Very dark coloured stools point to the need of a stimulant to the liver, such as podophyllin. When a thorough clearing out of the bowel is desired to relieve the overloaded system, or as a preliminary to the commencement of some medicinal treatment, the best means is a colocynth and hyoscyamus pill at night, and a double strong seidlitz powder in the morning. This also is suitable in the beginning of any inflammatory illness, of lung for example, but not when the bowel itself is affected. Constipation, along with dulness of spirits, headache, and sallow complexion indicates the need of a purgative which shall also stimulate the liver, such as podophyllin. The drastic purgatives ought not to be employed except when ordered by a medical man.

Remedies for Diarrhœa.

Looseness of the bowels may be due to several causes. It may arise from an excessive irritability of the bowel, which causes its peristaltic movement to be increased by the very smallest stimulus. An illustration of this is given by the kind of diarrhœa which threatens the person as soon as he takes food, or a short time after. The entrance of food so excites the whole bowel that its contents are hurried along with unusual rapidity. The remedies applicable to such a case are those which diminish irritability of the bowel, which soothe the bowel. Of these the most employed are **opium** in some form (see section on Drugs which Act on the Nervous System), **belladonna** (see also section just named), and **hyoscyamus** (also considered in the section noted). A single drop, or three drops, of laudanum taken before sitting down to a meal will frequently check this irritability.

Again, diarrhœa is often due to the presence of irritating material in the food, and the obvious remedy for this is to expel it from the bowel as quickly as possible, when the diarrhœa will cease. Thus, castor-oil, or rhubarb, is often the best remedy, the clearing out of the bowel being followed by an astringent action. A few drops of laudanum (4 or thereby) may be added to the oil or rhubarb. Indeed at the very outset of diarrhœa this treatment should in every case be adopted. Then one starts with the knowledge that the bowel is clear, and, if needful, other medicine can then be given.

Excessive acidity of the food is often a cause of diarrhœa, the high degree of acidity acting as an irritant. The bicarbonate of **soda**, or **potash**, **magnesia** carbonate, or some preparation of **lime** (see p. 843), will be the appropriate remedy in such a case. In children diarrhœa is very often due to the milk curdling in too large pieces in the stomach. These pieces are annoying to the bowel, as they are too large to be easily digested, and as they pass along the bowel they excite it more and more. The addition to the milk of a pinch of soda, a tea-spoonful or two of fluid magnesia, or a tea-spoonful of lime water, will prevent the too rapid curdling of the milk by the acid juice of the stomach, smaller curds will be formed, easy of digestion, and the diarrhœa will cease. In looseness of this kind the presence of small pieces of white curd in the stools sufficiently shows the nature of the complaint.

These methods of checking diarrhœa are indirect, the cause of the irritation of the bowel is removed, and the flow ceases. But there is a set of drugs which act upon the blood-vessels of the bowel, causing them to contract, diminishing the flow of blood through the mucous membrane of the bowel, and thus diminishing the production of intestinal fluid. In short, the opposite action is sought to that described under purgatives, by which one seeks to *increase* the flow of intestinal fluids. This astringent effect on the blood-vessels of the bowel is accomplished by **acids**, the acids named on p. 841. The **acetate of lead** is also valuable in this way (see p. 836).

There is next a group of substances which act upon the whole tissue of the bowel exposed to their influence, constringing it, and so checking any discharge, whether it be mucus or blood. The chief of these substances are catechu, kino, krameria or rhatany, oak-bark, and they are

dependent for their constringing action upon the tannic acid or some variety of it which they contain. The action of tannic acid and gallic acid we shall therefore first consider.

Galls are excrescences on a variety of oak found in Asia Minor, *Quercus infectoria*, due to the punctures and deposit of eggs of an insect, *Cynips gallæ tinctoriæ*. The irritation causes a swelling to occur which surrounds the egg, and within which the insect develops. When the nuts are broken a central cavity is seen in which the insect may be found, or it may have already escaped, in which case a canal will be found bored to the surface. The preparations of galls are:—

Tincture of Galls,......... Dose, ½ to 2 tea-spoonfuls.
Gall Ointment.
Gall and Opium Ointment.

The action of galls is practically the same as that of tannic acid, obtained from it. It is in the form of the gall or gall and opium ointment it is chiefly employed. This is used as a local astringent to the bowel in cases of piles, being simply applied to the part.

Tannic Acid is extracted from powdered galls with ether. It has a very strong astringent taste, and is very easily dissolved in water.

Tannic Acid,............................ Dose, 2 to 10 grains.
Glycerine of Tannic Acid contains 1 of tannin to 5 glycerine, dissolved by aid of heat.
Suppositories of Tannic Acid.
Lozenges of Tannic Acid,........ Dose, 1 to 6 lozenges. (½ grain of acid in each—the American lozenges contain 1 grain in each.)
Styptic Colloid (20 of tannic acid, 5 of alcohol, 20 of ether, 55 of collodion).

Uses.—Tannin coagulates albumin, and, applied to broken skin, causes it to contract by coagulating the fluids of the tissue. The blood-vessels of the part are reduced in size by the contraction of the surrounding tissues, and thus bleeding is arrested, as well as by the clotting of any blood by the influence of the tannin. In contact with the lining membrane of the mouth, gullet, stomach, and bowels, it produces dryness by coagulating the mucus, and the constringing effect produces a sensation of roughness and stiffness, diminishing the flow of blood along the vessels, and in this way, as well as by a direct action, diminishing secretion. These effects indicate in how many ways tannin is useful. It is employed to stop bleeding and discharges in all situations, from nose, throat, skin, bowels, womb, &c. For these purposes the glycerine compound is very well suited. The suppositories are useful in piles and other conditions of the lower end of the bowel. It is given also to arrest bleeding in organs besides the stomach and bowels. Its effect in checking bleeding in the stomach and bowels is readily understood, but it is also believed to check bleeding in other organs, such as the lungs, though given by the mouth. It reaches the blood and distant organs as gallic acid. For such bleeding, therefore, the use of gallic acid itself is to be preferred, since the local effect of tannic acid is not desired. It is seldom given for diarrhœa, and only in extreme cases.

Gallic Acid is prepared from galls by allowing a paste formed of pounded galls to ferment, gallic acid being derived from the splitting up of tannic acid.

Gallic Acid,................ Dose, 2 to 10 grains.
A glycerine and ointment are prepared.

Gallic acid is chiefly used in cases of bleeding from organs which can be reached only through the blood, such as the lungs and kidneys. In bleeding from the lungs, it is given in doses of 10 grains every two hours.

Catechu, as employed in medicine, is an extract of the leaves and young shoots of *Uncaria Gambier*, a shrubby climber indigenous to countries about the Straits of Malacca, and extensively cultivated near Singapore. Its preparations are:—

	DOSE.
Powdered Catechu,.........	10 to 30 grains.
Tincture of Catechu,.....	½ to 2 tea-spoonfuls.
Infusion of Catechu, ...	2 to 4 table-spoonfuls.

(Coarse powder of catechu 160 grains, bruised cinnamon 30 grains, boiling water 10 ounces; infuse half an hour and strain.)

Compound Powder of Catechu (contains catechu 4, kino 2, rhatany 2, cinnamon 1, nutmeg 1), .	Dose, 15 to 30 grains.
Lozenges of Catechu,...........	,, 1 to 3 lozenges.

Uses.—Catechu is used because of the effect of the tannic acid it contains. It is used as an astringent for the mouth in the case of soft bleeding gums, and for the throat in relaxed conditions, and for hoarseness. In these cases the lozenges are useful, or the infusion may be used as a gargle. It is employed as a lotion for bleeding from the nose, and as an application to cracked nipples. The tincture or infusion is very useful for diarrhœa in children, and is usually employed for adults in combination with a little tincture of opium and chalk mixture.

Black Catechu, Terra Japonica, or Cutch, an extract prepared from the wood of *Acacia Catechu* is to be distinguished from the above, which is pale catechu. Its dose is 5 to 15

grains, and in America a compound tincture and lozenges are made of it.

Kino is the juice obtained from incisions made in the trunk of the kino tree, indigenous to India and Ceylon, called buja in Bengal, the technical name being *Pterocarpus Marsupium.* It is imported in the dried state from Malabar. It contains a species of tannin from which it derives its most important qualities. Its preparations are:—

	DOSE.
Powdered Kino,.....................	10 to 30 grains.
Compound Powder of Kino (Powdered kino 15, opium 1, powdered cinnamon 4),..	5 to 15 ,,
Tincture of Kino,..................	½ to 2 tea-spoonfuls.

It is useful as a gargle for relaxed throats, the tincture being added to water, and it is employed in diarrhœa, and in the stomach disorder called pyrosis or water-brash. It is milder in action than catechu.

Rhatany is the dried root of *Krameria triandra,* a low shrub native to Bolivia and Peru.

	DOSE.
Powdered Rhatany,............	20 to 60 grains.
Extract of Rhatany,...........	5 to 20 ,,
Infusion of Rhatany (1 oz. in 20 boiling water, infused 1 hour and strained),	2 to 4 table-spoonfuls.
Tincture of Rhatany,..........	1 to 2 tea-spoonfuls.

Uses.—Rhatany is an astringent like the others, and its astringent effects are brought to play upon external affections, such as ulcers, fissure of the anus, cracked nipples, &c., as well as upon diarrhœa and other internal disorder. It is used as an injection in dysentery and for uterine complaints, also as an injection.

Red Gum is an exudation from the bark of *Eucalyptus rostrata,* the red gum-tree, and imported from Australia. Its preparations are:—

	DOSE.
Decoction of Red Gum,.........	2 to 4 tea-spoonfuls.
Liquid Extract of Red Gum,...	30 to 60 drops.
Tincture of Red Gum, ...	20 to 40 ,,
Syrup of Red Gum,................	30 to 60 ,,
Red Gum Lozenge,...Each lozenge contains 1 grain.	

Use.—Red gum is an excellent remedy for various kinds of relaxed mucous membrane. As the lozenge it is excellent for hoarseness and relaxed throat. Mixed with an equal quantity of starch in fine powder it may be blown into the throat. A tea-spoonful of tincture to 7 of water makes an excellent gargle, and a table-spoonful of the liquid extract to a pint of water forms an astringent injection for the bowels or genital passages, or to inject into the nostril, either to stop mucous discharge or bleeding. The tincture or liquid extract or decoction may be used for diarrhœa or bleeding from the bowel, or dysentery. In these latter cases it is often given with liquid extract of bael fruit.

Bael Fruit is the dried half-ripe fruit of *Aegle Marmelos,* the Indian Bael, or Bengal Quince, belonging to the orange order. The fruit resembles an orange of large size and the juice is gummy and pleasant flavoured. Its preparation is:—

Liquid Extract of Bael,.... Dose, 1 to 2 tea-spoonfuls.

It is extensively used in India, because of its astringent qualities, in the treatment of bowel complaints. In chronic diarrhœa following typhoid fever it has been found singularly efficient, and it is sometimes applied as a wash to the eyes when inflamed. It is frequently given in combination with liquid extract of red gum.

Logwood is sometimes used as an astringent in diarrhœa and dysentery. It is the sliced heart-wood of *Hœmatoxylon campechianum,* native to the shores of the Gulf of Campeachy, and naturalized in many of the West Indian Islands. A decoction and extract are prepared, the dose of the former being 1 to 2 ozs., and of the latter 10 to 35 grains. It colours the urine of those taking it pink. It is a mild astringent, quite suitable for use in checking diarrhœa of infants, to whom it may be given by the mouth or as an injection.

Oak and Elm Bark also contain tannic acid, and decoctions might be used as astringents like catechu, kino, &c. The decoction of oak bark is made of a strength of 1 of the bark to 15 of water, and the dose is 1 to 2 ounces; that of elm bark is 1 in 8, and the dose is 2 to 4 fluid ounces.

Alum, a compound of ammonia and alumina with sulphuric acid, the sulphate of ammonia and alumina, is a very strong astringent. Its preparations are:—

Powdered Alum, ...	Dose, 10 to 20 grains.
Dried or Burnt Alum,...	Externally for proud flesh, &c.
Iron Alum, ...	Dose, 5 to 10 grains.

Use.—Alum has a marked constringing action. The burnt alum, when applied to any raw surface, sears the surface, and is therefore used for "proud flesh," and for foul ulcers. When a weak solution of alum is taken into the mouth, its constringing action on the lining membrane is at once perceived; when it is absorbed into the blood and conveyed to the various tissues it appears to exert a similar effect upon them also. It is, however, used

chiefly for its local effect, and not much for effects after absorption into the circulation, though it is sometimes employed for arresting bleeding, as from the lungs, and discharges from various organs. Its local effect is obtained by using it in the form of gargles and washes. Thus a gargle of 60 grains alum, 2 tea-spoonfuls of honey, and 6 ounces of water is very useful for relaxed and inflamed throat, or soft spongy gums; another gargle of 60 grains of alum, ½ tea-spoonful of tincture of myrrh, and 4 ounces of water is useful under similar conditions and in ulcerated conditions of the mouth and throat. For checking bleeding from the mouth, nose, gums, anus, or from leech bites, it may be applied as a dusting powder, or in strong solution (60 grains to the ounce or stronger), upon a sponge or lint. For injection, alum may be used of a strength of 1 tea-spoonful and upwards of the powder to a pint of water, and the iron alum is a valuable preparation for this purpose. These are commonly used injections in discharges from the genital organs in women. A solution of from 1 to 3 grains in an ounce of water is good for inflammation of the eyelids accompanied by matter. Alum may be administered internally in the dose stated above, given in water or syrup or dissolved in white of egg solution, or in the form of alum whey. **Alum whey** is prepared by boiling 120 grains of alum in 1 pint of milk and straining. An ounce of this might be taken at a time. It may be thus administered for bleeding from the kidneys or bowels or for diarrhœa. The diarrhœa of typhoid fever is said to be better treated by alum than by any other astringent except acetate of lead; and in chronic dysentery it is valuable when used occasionally. Alum acts, however, as a purgative if given in large doses (60 grains), doubtless because of its irritant effects, and this quantity, or double, given in treacle or syrup acts as an emetic, draughts of warm water promoting the sickness once retching has commenced.

Iron Preparations are useful as intestinal astringents in diarrhœa and bleeding (see p. 817).

Copper Preparations are also sometimes used for diarrhœa, because of their astringent action on the bowel. The chief compound of copper used as a drug is:—

Sulphate of Copper, ... Dose, ½ to 2 grains.

Verdigris is a subacetate of copper, but is not used in medicine.

Uses.—Copper is very frequently used because of its astringent effects when applied directly to ulcers, wounds, &c., in the form of **blue-stone.** When applied in mass to the broken skin, or sprinkled on as a fine dust, it acts as a caustic, and is used for warts, proud flesh, unhealthy ulcers, and poisoned wounds. It is, however, far too frequently employed in domestic surgery. The "proud flesh," which sprouts from a healing wound, is to the uneducated eye a very undesirable thing, to be "burnt off" time and again, but to the surgeon it is the thing to be desired, as by it the wound is healed. If it becomes "exuberant," as the phrase is, he diminishes that tendency by the well-regulated pressure of a bandage, but probably the skilful surgeon almost never takes a piece of blue-stone between his fingers, unless it is to throw it away, as one has expressed it. When used in solution of 3 or 4 grains to the ounce of water it acts as a stimulant. A solution of 2 to 5 grains to the ounce is occasionally used as an injection, but not frequently, and specially in falling of the bowel and excessive secretion in that neighbourhood. Given in small doses internally, it acts as a tonic and astringent to the stomach and bowels in diarrhœa and dysentery. For such purposes it is often combined with opium, ¼ grain sulphate of copper, ¼ grain gum opium, made into a pill with confection of roses, and given occasionally. Dysentery is often benefited by an injection into the bowel of a pint of tepid water containing 10 to 20 grains of sulphate of copper in solution. Copper in small doses in pill has also been administered as a tonic to the nervous system in St. Vitus' dance and epilepsy. In large doses (2 to 10 grains of the powdered sulphate mixed with powdered sugar or dissolved in 2 ounces of water) copper is very useful as an emetic, especially in cases of laudanum or other narcotic poison. It does not produce nausea or depression and it acts rapidly. It is also used as an emetic in croup and bronchitis to expel material from the air-passages, the absence of depression being in such cases a great advantage. Poisoning by copper is not common, because of its emetic action, unless very large doses, leading to ulceration of bowel, have been taken. It is also employed as an antidote to phosphorus poisoning, 3 grains of the sulphate being given in water every few minutes, till vomiting occurs, after which a seidlitz powder should be administered.

Zinc is employed in cases almost identical with those for which copper may be used, but is much more freely used than the latter. Its preparations in common use are:—

	DOSE.	
Sulphate of Zinc,......	1 to 3 grains	as tonic.
	10 to 30 ,,	as emetic.
Oxide of Zinc,.........	2 to 10 ,,	in pill.
Acetate of Zinc, ...	1 to 2 ,,	as tonic.
	10 to 20 ,,	as emetic.
Valerianate of Zinc, ...	1 to 3 ,,	
Phosphide of Zinc,......	$\frac{1}{10}$ to $\frac{1}{3}$,,	

Zinc Ointment (80 grains of oxide of zinc to 1 oz. of benzoated lard).

Oleate of Zinc.

Chloride of Zinc, ... For external application only.

Uses.—Like copper, zinc when used in strength acts locally as a caustic, and when in weaker solution acts as an astringent and tonic. It is of very wide application in the form of lotion and ointment for wounds, sores, ulcers, and inflamed surfaces generally. The chloride of zinc is highly caustic, and is used in solid sticks to destroy tumours, and in strong solution to wash over foul ulcers. In solutions of 2 grains to the ounce it is a valuable tonic and stimulant to sores and wounds of various kinds. The sulphate of zinc in solutions of 1 and 2 grains to the ounce of water is used to bathe wounds, to bathe inflamed and mattering eyelids, and for injections to limit discharges from the womb, &c. It is also a soothing and cooling application to itching diseases of the skin, specially eczema. Zinc ointment is a soothing and healing ointment, and the more recent oleate of zinc is a better application, mixed with lard or vaseline to the amount of 1 part of the former to 3 of the latter. Oxide of zinc dusted very lightly in very fine powder is a soothing dusting powder for surfaces inflamed by rubbing against one another, such as frequently occurs in children. Taken internally, zinc acts as an astringent and tonic in small doses, and an irritant and emetic in large doses. The oxide is given occasionally for diarrhœa, and has been administered in chronic cases of diarrhœa to children with successful results. The sulphate may be given for the same purpose. The oxide, valerianate, and phosphide of zinc are used in nervous diseases, especially those of a convulsive type, such as St. Vitus' dance (chorea), epilepsy, whooping-cough. Two-grain doses three times a day may be given in pill, of the oxide and valerianate, and $\frac{1}{3}$ of a grain of the phosphide. The oxide of zinc is most frequently used to control excessive sweating, and in particular, the night sweats of consumption, for which it may be given in pill of 1 or 2 grains at bed-time. The sulphate and acetate of zinc are most valuable emetics (see p. 851).

Silver Salts have also astringent and tonic properties. The salts chiefly used are:—

Nitrate of Silver,............	Dose,	$\frac{1}{6}$ to $\frac{1}{3}$ grain.
Oxide of Silver,...............	,,	$\frac{1}{2}$ to 2 grains.

Uses.—Like copper and zinc, silver salts are used externally rather than internally. The solid stick of fused nitrate of silver, commonly called "lunar caustic," is applied to produce superficial destruction of tissue, in the case of chronic ulcers, the result being to stimulate healthy action. Solutions of varying strength (1 to 10 grains to the ounce) are used for like purposes, sore nipples, &c. The solid stick is applied to warts, and a stick is prepared with 1 part of silver nitrate to 2 parts of nitrate of potassium for similar uses, and called **mitigated nitrate of silver.** Internally, nitrate and oxide of silver are used for their tonic and astringent properties in chronic ulceration and inflammation of the stomach, and in chronic diarrhœa and dysentery. For this $\frac{1}{4}$ grain is the dose in pill with bread crumb. In epilepsy and St. Vitus' dance, it is given in similar doses, thrice daily, as a nerve tonic. In all these cases the use of the drug must not be continued beyond 3 or 4 weeks, because of the risk of staining the skin of the whole body brown, a staining which cannot afterwards be removed. If a piece of lunar caustic has been swallowed by accident, a draught of salt and water should be given immediately along with an emetic, for salt forms with it an insoluble substance, chloride of silver. The salt should be given along with gruel drinks or gummy drinks to protect the gullet, when the silver is vomited up.

Remarks on the Use of Remedies for Diarrhœa.—It is a mistake to suppose that on the occurrence of diarrhœa, the immediate thing to be desired is to check the discharge. In a very large number of instances, the looseness is the result of some article of food or drink which is irritating the bowel-walls, and the flux or discharge is the effort of nature to sweep it away. In the first instance, therefore, this effort should be aided, and aided so thoroughly that one may be certain all irritating substances have been swept out. If the diarrhœa still continues, as it may well do, if the irritation has been severe, then one can with confidence administer remedies to soothe the lining membrane, and to check the discharge. The preliminary step, then, is the administration of a full dose of castor-oil, to which a few drops (5) of tincture of opium (laudanum) might be added, or a full dose of rhubarb or senna, or magnesia, or even a full dose of some saline remedy such as seidlitz powder, fruit salt, or the like.

Thereafter, if necessary, a little bismuth (see p. 854) and soda, with or without laudanum (5 to 10 drops), is likely to be all that is necessary. If that is still insufficient some of the stronger astringents may then be given, catechu or kino, with, if needful, laudanum and chalk mixture (see p. 844). In dysenteric conditions of the bowel ipecacuanha is most valuable (see p. 852) either alone or with opium as Dover's powder, and lead and opium, dilute sulphuric acid and opium, tincture of red gum with decoction of bael fruit, and preparations of iron. Injections of starch and opium (see p. 874), decoction of logwood, oak-bark, &c., might be resorted to in extreme cases, but it is only after failure with these that a physician would think of trying the effect of strong astringents like alum, copper, or zinc salts. Throughout the whole treatment care must be exercised in the dieting, broths and soups and beef-teas being avoided, well-boiled arrowroot and milk being the chief food for a day or two, and iced milk, and sips of iced water being given for thirst.

Remedies for Flatulence of the Bowel.

The remedies employed in wind affecting the bowel are the same as those used when the stomach is distended with wind (see p. 849). In addition, it is sometimes possible to cause the wind to be expelled by the use of an injection into the lower bowel. Often flatulence of the bowels will be greatly and quickly relieved by passing the long injection pipe of a syringe several inches up into the bowel, and leaving it there for 15 or 20 minutes; the pipe disconnected from the syringe is meant, and the one used for vaginal injections is best.

Remedies for Worms in the Bowel.

There are two classes of remedies used against intestinal worms: one class belongs to the order of strong purgatives, jalap (p. 861), scammony (p. 861), and gamboge (p. 862). These, simply by their ordinary purgative action, expel worms from the bowel as they expel any other contents. They are, therefore, called **Vermifuges** (Latin *vermis*, a worm; and *fugo*, I drive out). A second class of remedies kill the worms, and require afterwards a purgative to expel them when dead. To this class the term **Vermicide** is applied (Latin *vermis*, and *cædo*, I kill). Both classes are grouped together as **Anthelmintics**, which simply means remedies against worms, without implying whether the remedies destroy the worms or not (Greek *anti*, against, and *elmins*, a worm). The chief drugs destructive to worms—vermicides—are as follows:—

Remedies for Tape-worm (see p. 168).

Male-fern (*Filix mas*).
Areca-nut.
Kamala.
Kousso.
Pomegranate Root.
Turpentine.

Remedies for Round-worms (see p. 173).

Santonica.
Santonin.
Spigelia Root (Carolina Pink).

Remedies for Thread-worms (see p. 174).

Injections into the bowel of common salt, quassia water, lime water, iron, alum, tannin, or substances containing it, such as catechu, kino, rhatany, logwood.

Male-fern.—The parts of the male-fern (*Aspidium Filix mas*) used are the dried rootstock with the bases of the foot-stalk and portions of the root fibres. Its preparations are as follows:—

	DOSE.
Powdered Male-fern Root,...	60 to 180 grains.
Liquid Extract of Male-fern (Oil of Male-fern),..........	30 to 80 drops.
Oleo-resin of Aspidium—(American),..................	10 to 20 ,,

Use.—The male-fern root and preparations are used only for the expulsion of worms, and specially the tape-worm, for which it is the most successful remedy, if given properly. The person should, the day before its use, restrict the amount of food taken, and take chiefly liquids —soups, milk, &c. A dose of purgative medicine ought also to be taken to clear the bowels of all material which would protect the worm from the action of the drug. Next morning ½ to 1 tea-spoonful of the liquid extract is taken in a mixture with 1 or 2 tea-spoonfuls of fresh mucilage and peppermint water or milk to make 2 ounces. An hour later a full dose of castor-oil is taken. If the worm does not come away repeat the treatment.

Areca-nut is the seed of the *Areca Catechu* or betel-nut tree.

Powdered Areca-nut,.... Dose, ½ to ¾ ounce.

Besides being used as an anthelmintic, it is employed as a dentrifice in the form of a paste made of the powder. As an anthelmintic it is to be employed in a way similar to male-fern.

Kamala is a fine orange-red powder consisting of the hairs and glands obtained from the

surface of the fruits of *Mallotus philippinensis* (*Rottlera tinctoria*), which grows wild in Australia, Eastern China, India, Southern Arabia, and Abyssinia.

Dose, 30 grains to ¼ ounce.

After taking the powder the worm is usually expelled in a few hours; if not, the dose should be repeated in three hours.

Kousso or Cusso—the female flowers and tops of *Brayera anthelmintica*, a handsome tree of the rose order, native to Abyssinia.

Powdered Kousso,........ Dose, ¼ to ½ ounce.
Infusion of Kousso, ... ,, 4 to 8 ounces.
(¼ oz. kousso in coarse powder, 4 oz. boiling water; infuse in a covered vessel for 15 minutes, and drink when cold without straining.)

For the expulsion of tape-worm by this drug, it should be taken after the patient has fasted for a day. There is an active principle called **kosin** or **coussine,** of which a dose of 20 grains is sufficient, which does not tend to produce the nausea and vomiting sometimes occasioned by the infusion. In America there is a preparation used, the fluid extract of brayera, of which 8 fluid ounces is the dose.

Pomegranate Root Bark is the dried bark of the root of *Punica Granatum*, indigenous to South-western Asia, but now met with in all sub-tropical countries, grown on the shores of the Mediterranean.

Decoction of Pomegranate Root Bark, ... } Dose, 1 to 3 fluid ounces.
(2 ounces of sliced root in 2 pints of water, boiled down to 1 pint and strained.)

The pomegranate root bark is astringent, and requires therefore to be followed by a purgative when used for tape-worm. Several doses are often required; and it is not so active as the male-fern root. It contains two alkaloids, **pelletierine** and **iso-pelletierine.** Of the former there are two compounds, both used for tape-worm.

Sulphate of Pelletierine, ... Dose, 5 to 8 grains.
Tannate of Pelletierine,.... ,, 8 grains.

Five to 8 grains of the sulphate taken fasting, and followed in 15 minutes by a full dose of tincture of jalap (p. 861), causes expulsion of the whole tape-worm in nine cases out of ten. For children of 13 years, half this dose is given, and for infants one-tenth. Of the tannate 8 grains, followed in 2 hours by an ounce of castor-oil, is likely to be effective without colic or headache. Quicker action is obtained if black draught (p. 857) or the compound infusion of senna be used instead of the castor-oil, and the rules as to diet laid down for the employment of male-fern should be followed.

Turpentine is an oleo-resin which exudes from *Pinus australis* and other species of pine, and it occurs in tough yellowish masses. Distilled from this resin is the oil or spirit of turpentine of common use.

Oil of Turpentine,.................. Dose, 5 to 30 drops; as an anthelmintic, ½ to 2 tea-spoonfuls.
Confection of Turpentine,. .... ,, 1 to 4 tea-spoonfuls; as an anthelmintic, 1 to 2 ounces.
(Oil of turpentine 1 oz., liquorice powder 1 oz., clarified honey 2 ozs.)
Injection of Turpentine.
(Oil of turpentine 1 oz., mucilage of starch 15 ozs., the quantity for one injection.)
Liniment of Turpentine.
(Oil of turpentine 16 ozs., camphor 1 oz., soft soap 2 ozs.; dissolve the camphor in the oil, then add the soap and rub up till thoroughly mixed.)
Acetic Liniment of Turpentine—St. John Long's Liniment.
(Oil of turpentine 1 oz., acetic acid 1 oz., liniment of camphor 1 oz.; mix.)

Uses.—Turpentine when applied to the skin reddens it, producing a burning sensation, and if it be applied on a cloth and kept covered, a blister is produced. It acts, that is to say, as an irritant. Its vapour, when inhaled, similarly irritates the air-passages, causing a feeling of constriction of the chest. Taken internally in small doses, it produces a feeling of heat at the stomach, and in excessive doses acts as an irritant poison, setting up inflammation and ulceration. It is employed externally as a stimulant and counter-irritant in inflammations—applied, for example, to the chest and back in pleurisy, inflammation of the lungs, &c., and to the abdomen in inflammation of the bowel. Poured upon boiling water, a tea-spoonful at a time, it is used as an inhalation in chronic lung affections with discharge. It is used as a liniment for painful joints, neuralgia, sciatica, &c. It is given internally in doses of 10 drops, rubbed up with 30 grains powdered gum acacia and then with 1 ounce of water, in cases of bleeding from ulceration of the bowels in typhoid fever, and it is repeated every 2 hours, watchfulness being exercised lest sickness, vomiting, and symptoms of intoxication arise. It is also valuable in small doses as a stomach stimulant, especially in cases of hysterical flatulence, though its taste and

smell render it unpleasant and therefore not much used, and it also expels wind from the bowel, and in larger doses acts as a purgative. Given in the larger doses it is destructive to tape-worm, and is a valuable injection for thread-worms. It must not be forgotten that comparatively small doses are apt to irritate the urinary organs, and produce a feeling of heat and spasm about the urinary organs, difficulty of passing water, and pain in the small of the back.

Santonica is the unexpanded flower-heads of a species of *Artemisia*, imported from Russia, called also Levant worm-seed. The plant belongs to the same order as the daisy—Compositæ. From it **Santonin** is prepared, the active principle of the drug.

Santonica,...	Dose, 10 to 60 grains.			
Santonin,....	,,	1 to 4	,,	for a child,
		2 to 6	,,	for an adult.

Santonica and santonin are the best remedies for the round-worm, and are less destructive to the thread-worm. They should be given at night, followed by a brisk purgative on the following morning. A single dose of 2 grains of the latter has sufficed to expel 166 round-worms. It frequently affects sight, causing everything to appear yellowish or greenish yellow, and it colours the urine a bright yellow, giving rise also sometimes in children to inability to retain the urine. If it be given at night, the effect on vision is likely to pass off before morning. Excessive doses cause headache, giddiness, and vomiting, and arrest of the breathing. In cases of poisonous doses having been used, an emetic should be used to empty the stomach, hot stimulants should be administered, and artificial breathing maintained.

Spigelia, Maryland pink or worm-grass, found in shady woods in the southern parts of the United States of America, is employed in America to destroy worms.

Powdered Spigelia Root,...	Dose, 60 to 120 grains.
Fluid Extract of Spigelia,.	,, 1 to 4 tea-spoonfuls.

"The most usual and best form of the medicine is that known as 'worm tea,' namely, ½ ounce spigelia, senna and fennel-seed of each 120 grains, manna 1 ounce, boiling water 1 pint. Infuse. Dose, half a wine-glassful three times a-day for a child two years old." Excessive doses of the drug produce poisonous effects, hot dry skin, nervous excitement of a hysterical kind, pain in the forehead and eyes, stiffness and swelling of the eyelids, squinting, great muscular trembling, &c., and the remedies are wine, ammonia, and other stimulants.

Injections into the Bowel: Enemata: Clysters.

Injections are given for a great variety of purposes. Prepared foods are injected when, owing to some condition of gullet or stomach, foods cannot be administered in the usual way. These are called **nutritive enemata.** Then there are **stimulant enemata.** The most frequent object of an injection into the bowel is to clear out the bowel of its contents, either by mere washing out with water—**simple enemata,** or by the injection of purgative drugs—**purgative enemata.** Injections are also made to restrain bleeding and discharges of other kinds—**astringent enemata,** and soothing drugs may be introduced in the same way—**sedative enemata,** while they may be used against worms—**anthelmintic enemata.** A note of a few of these injections may be given. The injection is administered by means of a syringe (see Plate VIII). The syringe is first washed in hot water to make certain it is in order; then it is carefully emptied, and then filled with the injection material. The tube is then oiled and passed up into the bowel by means of a gentle turning movement, when it should go in quite easily. The injection must be made very slowly and steadily, to avoid irritating the bowel, and causing it at once to expel the whole material.

Beef-tea and Cream Enema.—Mix 4 to 8 ounces of strong beef-tea, an ounce of cream, ½ ounce of brandy, or 1½ ounces of port wine. This may be administered twice or thrice in 24 hours.

Peptonized Enema.—Mix 4 ounces of strong beef-tea with 4 ounces of milk gruel; add half a tea-spoonful of bicarbonate of soda and a dessert-spoonful of liquor pancreaticus (p. 847), and inject.

A Nutritive Enema may be made of any good broth (without vegetable, of course), or beef-tea made gelatinous, or of raw egg beaten up with milk and peptonized (see p. 847). A cupful of milk mixed with 2 tea-spoonfuls of Carnrick's beef peptonoids, with ½ tea-spoonful bicarbonate of soda and a dessert-spoonful of liquor pancreaticus, makes an excellent enema for children, half of this quantity being injected at a time.

Where such injections are used for any time, it is well to clear out the bowel occasionally by a copious injection of warm water. It is desired, of course, that the whole injection should be retained. It is an aid to securing this if the patient lies on the left side, and if after the enema has been given a folded napkin is kept firmly pressed against the outlet of the bowel

for a few minutes, till the desire to expel anything has passed away.

Simple Opening Enema.—Inject from a pint upwards of tepid water. This is used for emptying the bowel without further disturbance. It is exceedingly useful for children in convulsions or in fever, or simply for constipation. The bowels can be caused to act almost at once, if a sufficient quantity of water be injected. Even in the case of children a larger quantity than a pint may be used. It is the author's practice to inject as much as possible, *but slowly;* no harm can possibly be done. The result is that soon the bowel can retain it no longer, and everything is swept out almost in one rush. If any hard masses have been lying in the bowel, the large quantity of water, by distending the bowel, separates them from the walls of the canal, and allows of their being swept down.

Soapy Water Enema.—12 ounces of warm water with 1 ounce soap dissolved is somewhat more active than the simple water. About $\frac{1}{2}$ to 1 pint of it may be used.

Salt and Water Enema.—A dessert-spoonful to 2 or 3 table-spoonfuls of common salt are dissolved in 1 or 2 pints of warm water, and slowly injected. This is used when it is desired to act more than once upon the bowel. The action of the salt induces a temporary flux or catarrh of the bowel and recurring motions. It is useful in obstinate constipation and when head symptoms are present, symptoms of congestion of the brain, for example, and the desire is to bring down as much blood as possible from the head to the bowel, and keep it there.

Epsom Salt Enema.—Sulphate of magnesia (Epsom salt) 1 ounce, water 15 ounces. Used for a like purpose to the preceding.

Aloes Enema.—Mix 40 grains powdered aloes with 15 grains carbonate of potash and 10 fluid ounces of a thick solution of boiled starch. The whole of this may be injected when a purge is desired, but only 2 or 3 ounces of it is used to destroy thread-worms.

Assafœtida Enema is a very prompt way of removing wind from the bowels, especially in hysterical people. It is made with 30 grains of assafœtida, rubbed up with 4 ounces of water.

Glycerine Enema.—The injection of a tea-spoonful of glycerine is often sufficient to relieve constipation.

Castor-oil Enema.—Castor-oil 1 ounce, mixed with 12 ounces thick solution of boiled starch. To this 2 tea-spoonfuls of tincture of assafœtida may be added if flatulence exists.

Turpentine Enema.—Of turpentine oil 1 ounce, mixed with 15 ounces starch mucilage. This is useful in hysteria and hysterical flatulence. It is also employed to destroy thread-worms. In such a case 4 or 5 ounces only should be given, so that they may be retained for a time.

Opium and Starch Enema.—Half a tea-spoonful of laudanum in 2 fluid ounces of starch mucilage. This is employed to relieve pain, to check diarrhœa, &c. As it is desired to retain it, a small quantity only is injected. The quantity of laudanum is for an adult. For a child one ought not to use such a drug without the sanction of skilled advice, which would also indicate the amount. But in the case of diarrhœa in children, sometimes the injection of 2 or 3 ounces of a thick solution of starch alone is productive of much good, by coating over the irritated and inflamed bowel, and calming its excitability.

Astringent Enemata.—If the opium and starch enema fails in diarrhœa, others may be tried. To the starch 2 tea-spoonfuls of hazeline may be added, or half a tea-spoonful of the liquid extract of witch-hazel. In the purging of typhoid fever, if these fail the following may be tried:—Oil of turpentine 30 drops, tincture of kino 2 tea-spoonfuls, liquid extract of opium 10 drops, mucilage of starch 2 ounces. Another form is as follows:—Subnitrate of bismuth 20 grains, tincture of catechu 1 tea-spoonful, liquor hydrochlorate of morphia 30 drops, mucilage of starch 2 ounces; mix and inject the whole.

Enema for Piles.—Inject daily a tea-spoonful of tincture of witch-hazel in 3 ounces of tepid water.

REMEDIES WHICH ACT UPON THE LIVER.

Stimulants to the Liver.

In this section there has been already considered a number of drugs which stimulate the liver and promote the secretion of bile. These have all been at the same time purgatives, and drastic purgatives when given in large doses—podophyllin, &c. (see p. 864). There are, however, several drugs which excite the liver to activity in various ways without producing purging. These must now be noted. Subsequently the drugs will be mentioned which diminish the activity of the liver. The chief of these are dilute nitro-hydrochloric acid (see p. 841) and chloride of ammonium (see p. 843). In enlargement of the liver in tropical coun-

tries, the latter drug is said to be beneficial, in doses of 5 grains and upwards. Phosphorus (p. 826), arsenic (p. 822), and antimony (p. 853), by their slow action upon the chemical changes going on in the tissues, also modify the activity of the liver, exciting it to renewed activity.

Drugs which Depress the Liver.

Any substance which markedly irritates the bowels, such as purgatives, diminishes the activity of the liver, and thus a powerful purgative, which does not at the same time stimulate the liver, will quickly relieve that organ, when some acute disorder is threatened. Quinine and opium are also powerful depressants of the liver to be employed in similar circumstances. Nevertheless, nothing will so quickly help to relieve the liver as certain restrictions in the diet. The avoidance of sugar, starch, and fat, the three substances in the assimilation of which the liver is most concerned, will diminish the quantity of material with which the gland has to deal or which it is its business to store up. In cases of sluggish liver, if, with such restriction of diet, active exercise be freely indulged in, and the bowels be kept free by an occasional saline purge, the waste products of the activity of the kidney will be rapidly removed, to the great relief of the organ.

Section IV.—DRUGS WHICH ACT ON THE GLANDULAR SYSTEM.

Stimulants to Enlarged Glands:
- *Iodine;*
- *Lime* **and its Preparations—the Sulphide, Muriate, and Phosphate—Their Value in Scrofulous Diseases of Glands.**

Cod-liver Oil.

Roughly speaking there are two different sets of glands in the body. There are, first of all, those glands whose business it is to produce, from raw material supplied by the blood, some fluid which is to be employed in the body for some special purpose, or which is to be separated and cast out of the body as waste. Thus there are the salivary glands (p. 137), producing saliva to moisten the mouth, to aid in swallowing, and to assist in the digestion of starch; there are the gastric glands, producing the gastric juice, the pancreas, producing the pancreatic juice, the intestinal glands, producing the intestinal juice, the liver (also a gland), producing the bile, all for purposes of digestion; there are the kidneys separating urine from the blood, and the sweat glands of the skin separating water mainly, to be cast off from the body; and there are the minute glands embedded in every mucous membrane for the purpose of keeping it moist; the drugs acting on these glandular organs are discussed in other sections, those of the digestive tract in Section III., those of the skin in Section VII. But, in the second place, there is the large number of glands which produce no special material, which have no outlet at all, which are interposed in the pathways of some of the nutriment absorbed from the bowel (the chyle, see p. 200) as it passes onwards to enter the circulation, or interposed in the pathway of those vessels—the lymphatics—which pick up fluid from the tissues and pass it back into the circulation (see p. 203). These glands have no outlet because they manufacture no special juice. Their business is to work up the chyle absorbed from the bowel, or the lymph absorbed from the tissues, by acting upon it in some way unknown to us, and fit it for becoming part of the circulating blood. Now if we think what an important function this is, a most vital part of the blood-forming business, if we realize how profoundly any serious disorder of the activity of these glands will affect the health of every tissue and organ of the body, we shall understand how valuable information would be as to the drugs which act upon these glands and as to the nature of their action. Let us take an illustration. "The glands of the bowels" is a popular phrase for the mesenteric glands (p. 201), and we know what apprehension is excited when there arises any suspicion of disease affecting them. The apprehension is well grounded. For we have already described (p. 200) how a large portion of the nutritive material of the food is picked up by vessels in the bowel, called lacteals, and carried direct to these mesenteric glands before being poured into the current of circulating blood. Any disease which seriously affects these glands may at once interfere with the course of this nourishing material, and may prevent its ever reaching the blood. It is not, then, to be wondered at if rapid wasting of body

and exhaustion of strength are among the early and chief signs of such glandular disease. Scrofula (p. 431) is another illustration of the great importance of the lymphatic glands in the general nutrition of the body. Again, the important parts these glands play in the interception of poisonous material has been pointed out (p. 203), and the significant share they have in disseminating such diseases as cancer has been referred to (p. 434). All these facts illustrate how valuable would be any drug which was known to have direct and powerful effects upon glands, if it were possible to give it any direct application in disease. As a matter of fact, however, it can hardly be said that there are any medicines which have a specific action limited to glands. They can be acted upon only by that class of remedies which have a general effect upon the nutrition of the whole body by influencing the character of the blood or by modifying tissue change. The remedies which have these effects have already been noted in Sections I. and II. It will, therefore, be sufficient merely to mention those specially in use in affections of glands, and reference can then be made to the page where their action is more fully described.

Iodine, in some form, is a favourite remedy in chronic swelling of glands, and in scrofulous conditions. Sometimes it is applied as tincture, painted over the enlarged gland, sometimes it is given along with a preparation of iron, in the form of iodide of potassium; and a specially useful remedy, under such circumstances, is the syrup iodide of iron. For these preparations and their uses see p. 825.

Lime or calcium preparations stand probably next in regard for supposed virtues in glandular affections, specially such as are of a tubercular or scrofulous character (see p. 430). The main preparations and uses of lime have already been mentioned on p. 844. But there are other preparations, not named on that page, used almost exclusively for scrofulous and other enlargements of glands, for bone diseases, and in wasting diseases. They are as follows: —

	DOSE.	
Sulphide of Calcium (or Sulphurated Lime), ...	$\frac{1}{10}$ to 1 grain.	
Chloride of Calcium[1] (Muriate of Lime), ...	1 to 3 grains	for children.
	10 to 20 ,,	for adults.
Phosphate of Lime, ...	10 to 20 ,,	
Hypophosphite of Lime, ...	5 to 10 ,,	

[1] This is not the "chloride of lime" employed as a bleaching powder, and for purposes of disinfection, the proper name of which is *chlorinated* lime, though it is commonly called "chloride of lime." The two must not be confounded.

The so-called sulphide of calcium is principally used to check the formation of matter. If a gland be inflamed, and suppuration be feared, this preparation is given in doses of from $\frac{1}{10}$ to $\frac{1}{2}$ grain in pill four or five times a day, and is sometimes successful in checking it. In larger doses it is likely seriously to irritate the stomach. The chloride of lime was strongly recommended by the late Dr. Warburton Begbie, of Edinburgh, in the case of children with swollen glands of the neck, or children who suffered from weakness, loss of appetite, and diarrhœa, of a scrofulous character. "The cases in which I have had occasion most frequently to employ the muriate of lime have been instances of struma (scrofula), the most notable feature of which was the enlargement of the lymphatic glands in the neck. In the earlier cases which fell under my observation, recourse was had to the remedy, either because what appeared to be a fair trial had already been given to iodine, or its preparations, chiefly the iodide of potassium, and syrup of the iodide of iron, or to cod-liver oil. Frequently both iodine and cod-liver oil had been employed without appreciable benefit, or it had happened that these remedies had disagreed. Under such circumstances, then, muriate of lime was prescribed. For several years, however, with a growing and latterly extended experience of its virtues, I have not hesitated to order the remedy when no such proof was afforded, either of the failure, or of the intolerance on the patient's part, of the other medicines. I am not able to affirm that the remedy has always, that is, in every case, answered my expectations. . . . But it is in my power to assert, that many instances of very great enlargement of the cervical glands (glands of the neck) and several examples of other maladies, which will be shortly referred to, have apparently yielded to its use." One of the other maladies referred to is that met in childhood with symptoms resembling those of consumption of the bowels (tabes mesenterica, p. 166); and in it he observed the use of the remedy to be followed by the cessation of protracted diarrhœa and exhausting perspirations, by a diminution of fever, by improvement in appetite, the gaining of flesh, and a gradual restoration to the condition of health. Children suffering from loss of appetite, pallor, loss of flesh, protuberant belly, wasted limbs, and feverishness, he found greatly benefited by its use. He says that in such cases it requires to be taken for a considerable time—for weeks, it may be even months—before its beneficial effects are visibly produced. He

recommends it to be taken after meals in milk, twice or thrice daily. It may be employed in the form of the solution of chloride of lime, of which 15 drops contain about 10 grains. This dose may be given to young persons (and less in proportion to children) thrice daily, and may be gradually increased to 30 or 40 drops. Too large a dose is likely to produce loss of appetite, sickness, and pain in the stomach. The phosphate and hypophosphite of lime are employed in similar affections, usually in combination with other substances, as compound syrup (see p. 817).

Cod-liver Oil is, however, perhaps of more value in glandular affections than even iodine or lime preparations. It is the oil extracted from the fresh liver of the cod, *Gadus Morrhua*, with the aid of heat. Its beneficial effects are not due to any specific action on glands or any other organs, since it is a food rather than a medicine; but it is much more readily absorbed and passed into the circulation than other oils. Not only does it thus readily gain access to the tissues, but it is also readily taken up by them, and thus it stimulates nutritive changes all over the body, and improves the general health. It quickly improves the quality of the blood, and is thus a blood tonic, while it is to be remembered that it can gain the blood current only by passing through the lymphatic glands. It may be applied externally in the case of feeble children, who cannot bear it on the stomach, by rubbing it into the skin. It appears to be of some value, even for nutritive purposes, when used in this way. But it is also used externally for scaly skin diseases to soften the skin, in psoriasis, for example. Internally it is given in all cases of defective nutrition, specially in glandular, scrofulous, and consumptive affections. For rickety children it is usefully combined with preparations containing lime, such as Parrish's chemical food (p. 817), or the compound syrup of hypophosphites. In all chest affections, specially in chronic bronchitis, it is very valuable. It exerts a most notable influence in diminishing the amount of the expectoration. In consumption of the lungs it is constantly administered, not because it directly tends to cure the disease, but because by its nutritive properties it does something to save the tissues that are specially subject to the wasting process. From time immemorial it has been a popular remedy for chronic gout, rheumatism, rickets, and scrofula. It acts as a tonic in nervous diseases, and may be combined with iron preparations, for neuralgia, hysteria; and in convalescence from all acute diseases, more particularly in damp and changeable climates, are its beneficial effects shown.

As a rule it is not to be given when the bowels are loose, lest the diarrhœa be increased. But if the diarrhœa arises from conditions of general weakness, &c., which the oil might help to rectify, it should be cautiously tried, in small quantities, in combination with something slightly astringent, such as chemical food. It will often prove useful in constipation.

Cod-liver oil is best given not immediately after food, and certainly not on an empty stomach, but an hour or two after food. Small quantities should be begun with, and they may be slowly increased, as the person becomes accustomed to them. Sometimes a dose can be tolerated without discomfort at bed-time, when it would occasion sickness at any other period of the day. Those who after patient trial cannot get accustomed to its use, ought not lightly to give up all attempts, but should try one or other of the numerous disguises now in the market—cod-liver oil emulsion, cod-liver oil and malt extract, peptonized cod-liver oil and milk (Carnrick's), &c. Many persons find it easily and agreeably taken when it is floated on the surface of claret. Its dose is from 1 tea-spoonful to 2 table-spoonfuls.

When it is persistently rejected by the stomach, combining it with pure ether should be tried—10 drops of pure ether to 1 tea-spoonful of the oil. The ether aids its digestion by stimulating the flow of pancreatic juice.

SECTION V.—DRUGS WHICH ACT ON THE LUNGS AND AIR-PASSAGES.

Remedies which Stimulate the Lungs and Air-passages.

Stimulants to the Circulation in the Lungs and Air-passages:
Ammonia, Digitalis, and Aromatic Oils.

Stimulants to Secretion from the Air-tubes—Expectorants:
Heat, Ammonia, Alcohol;
Senega; Balsams of Peru and Tolu;
Copaiba and Cubebs; Ammoniacum, Galbanum, Myrrh, Benzoin, Tar, &c.;
Ipecacuanha;
Inhalations of Carbolic Acid, Creasote, Iodine, Turpentine, Essence of Pumiline Pine, Eucalyptus Oil.

Remedies which Soothe the Lungs and Air-passages.

Remedies which Lessen the Circulation in the Lungs:
Heat and Blisters;
Antimony, Aconite, and Ipecacuanha.

Remedies which Diminish Expectoration:
Acids and Belladonna.

Remedies which Relieve Spasm:
Lobelia, Stramonium, Conium, and Tobacco.

Speaking broadly we may say there are two chief ways by which the lungs and air-passages can be influenced by drugs—the one is by stimulation, the other is by a soothing or depressing action. In order to understand how these effects may be brought about, it is necessary to recall some of the chief facts already mentioned in the section describing the structure and functions of the lungs and air-passages (p. 249). The lungs consist essentially of a large number of minute vesicles, cells, or sacs filled with air, communicating with one another by means of fine tubes—the bronchial tubes, and finally communicating with the outside air. In the walls of these air-cells are situated the vessels through which the blood flows; and while the blood flows through these vessels, it is exposed on all sides to the air of the vesicles, only a thin wall intervening between it and the air, so that exchanges readily occur between them. The tubes or air-passages have layers of involuntary muscle in their walls, by whose contraction the diameter of the tubes is diminished. The larger tubes have plates or partial rings of gristle in their walls to prevent their complete closure, but the smaller tubes are not so provided, and the contraction may be so great as practically to block the passage. Then the inner lining membrane of the bronchial tubes contains small mucous glands, which secrete a material for keeping the membrane moist, and this lining membrane has on its inner surface, except in the case of the finest terminations of the bronchial tubes, fine hair-like processes, or cilia (p. 252), which, moving always in one direction, sweep any material in the tubes upwards to the mouth, whence it is in time expelled. Now, it is plain that the gaseous exchanges going on in the lungs will materially depend upon the rate at which the blood is flowing through the vessels in the walls of the air-cells. This will, to a large extent, depend on the force and frequency of the contractions of the heart, for it is by the contractions of the heart that the blood is driven from the right side of the heart through the lungs, being purified on its course, to the left side, whence it is distributed throughout the body. This circulation through the lungs will, therefore, be quickened by any means which strengthen and stimulate the heart. Remedies which have this effect have been already named in Section II., and the chief of them are ordinary stimulants, ammonia, digitalis, squill, aromatic oils, such as have been named on p. 848 for flatulence, and senega. Another kind of stimulating effect is that which acts specially upon the lining membrane of the air-passages and their glands, increasing the amount of material poured out, relieving a dry and swollen condition of the membrane, and providing a larger supply of material to be swept out. This effect is produced by warm foods and drinks, and by ammonia and other alkaline remedies (see p. 843), by sulphur, by ipecacuanha, iodide of potassium, senega, squills, antimony, turpentine, camphor, balsam of Peru and Tolu, and aromatic oils. For example, in the early stage of

COMMON THORN APPLE – THORNY APPLE OF PERU.
DEVIL'S APPLE – JAMESTOWN WEED.
(Datura Stramonium)

WOODY NIGHTSHADE or BITTER SWEET.
FELLOWWOOD.
(Solanum Dulcamara.)

CUCKOO PINT or WAKE ROBIN.
LORDS & LADIES. COMMON ARUM.
(Arum Maculatum.)

acute bronchitis the lining membrane is swollen, red, and dry, great difficulty of breathing is experienced, and shrill wheezing sounds are heard widely spread over the lungs, and there is a dry and very irritable cough. The use of a remedy which causes the glands to pour out a copious secretion will speedily relieve the inflammation, will by moistening the membrane diminish its irritability, and will, thereby, greatly relieve the breathing. Again, in the latest stage of the same disease, and in others, accompanied by a scanty tough spit, which maintains a constant cough owing to the great difficulty of getting the tough phlegm swept up, any remedy which will increase the secretion, and so produce a more abundant and watery spit, will greatly relieve the symptoms. But, still more, the stimulating effect of various remedies is experienced by the muscular coat of the bronchial tubes, and by the cilia of the surface of the lining membrane, and the result of their increased activity is to sweep up more vigorously any offending material lying in the tubes. Cough will thus be increased, and that may seem at first blush a disadvantage; but so long as cough is the means of removing material which, if allowed to accumulate, will speedily fill up the air-passages, and render continued breathing exceedingly difficult or next to impossible, it is not a disadvantage, but a necessity. Finally, it has been pointed out in Section IX. A, p. 256, that the whole process of breathing is under the influence and control of the nervous system, and remedies may be given which will increase the excitability of the nerves of respiration, and so stimulate the breathing process.

Now all these actions may be reversed. Thus, the quantity of blood flowing through the lungs may be diminished and its speed lessened by means, such as mustard applications, which withdraw the blood to other organs, or by means which weaken the heart's action, such as aconite, antimony, and ipecacuanha. The quantity of mucus secreted by the glands of the bronchial tubes may be diminished by belladonna, stramonium, and hyoscyamus; and this effect it is very desirable to produce in chronic bronchitis and other diseases, with copious expectoration. The irritability of the whole lining membrane of the tubes may be lessened by warm food and warm applications, and by drugs like opium, ether, and chloroform. This effect it is very necessary to produce for the relief of cough of a dry, hacking kind. Such a cough is often due, not to the presence of any material to be expelled, but to the great irritability of the lining membrane, so that a mere whiff of cold air will start off a severe fit of coughing. The excitability also of the muscular coat of the tubes may be lessened, so that they tend to remain relaxed, allowing the tubes to be widely open. This is a most desirable result to achieve in spasmodic conditions, such as that of dry asthma, and which yields for a time at least to chloroform, ether, and nitrite of amyl (p. 837). Belladonna, stramonium, hyoscyamus, lobelia, tobacco, opium, and Indian hemp have a similar effect.

We see, then, that in disease of the lungs and air-passages the chief remedies employed are such as have either a stimulating or a soothing effect on the circulation, or on the secretion of mucus, or on the nerve and muscle part of the breathing apparatus. It may be noted that some stimulating remedies have an influence in all these various ways. Ammonia, for example, stimulates the circulation, the secretion from the glands, and the respiratory nerves; on the other hand, ipecacuanha depresses the circulation, but stimulates secretion and the nervous apparatus.

REMEDIES WHICH STIMULATE THE LUNGS AND AIR-PASSAGES.

Stimulants to the Circulation in the Lungs and Air-passages.

It is unnecessary to go over such remedies as stimulate the circulation in the lungs in detail. All heart tonics and stimulants (see p. 832) will naturally strengthen the circulation through the lungs. But it may be pointed out that a purplish or blue appearance of the skin of the face and lips is an indication of the need of some such stimulant. Ammonia, in the form of smelling salts, may be of use if the weakness is but temporary, and the carbonate of ammonia, in 5-grain doses repeated several times daily, and the aromatic spirit of ammonia (p. 843) are valuable, while tincture or infusion of digitalis with ammonia is, in weak conditions of the heart, a most effective combination. The pungent aromatic oils (p. 849) have a similar, though less durable, effect. Then a brisk purge, by unloading the liver and bowels, quickens the circulation through the lungs.

Stimulants to Secretion from Bronchial Tubes—Expectorants.

Expectorants is the term applied to such remedies as assist in the expulsion of phlegm from the air-passages. Now, a drug may be an expectorant which simply loosens the spit, so as

to permit it to be more easily brought up. Warmth has such an effect, and may be applied to the chest in the form of a hot poultice, or may be employed in the shape of warm air or steam which is inhaled. Another drug may be an expectorant which simply increases the mechanical force brought to bear in coughing up the spit. Thus an emetic acts mechanically; the act of emptying the stomach serving also to expel material collecting in the bronchial tubes. For this purpose ipecacuanha wine is best, or if there is much depression an emetic dose of carbonate of ammonia—30 grains. The chief expectorants, however, are those which by their stimulant, or slightly irritating effect, increase the flow of blood to the lungs and air-passages and thus cause an increased flow of secretion. All the drugs mentioned under stimulants to the circulation will do this, but the chief are ammonia, alcohol, squill, senega, and balsams. Ammonia and alcohol have been already sufficiently discussed. Squill and its preparations have been noted on p. 833. Let it be remarked here that the fact that squills has a stimulating effect or irritating effect ought to prevent its promiscuous use in every case of cough, bronchitis, &c. Syrup of squills and ipecacuanha wine are the two domestic remedies for cough and lung affections. To the ipecacuanha wine there is little objection, to the syrup of squills there is often much. If cough is the result of an irritable condition of the bronchial tubes where there is little or no phlegm to expel, its use can only be hurtful by adding to the irritation, and in acute attacks of bronchitis it ought not to be employed. In chronic bronchitis, with copious spit, it is useful.

Senega is the dried root of *Polygala Senega*, a native of North America. It contains an active principle, **senegin** or **saponin**. Its preparations are:—

Powdered Senega, ...	Dose,	10 to 20 grains.
Infusion of Senega, ...	,,	1 to 2 ounces.
Tincture of Senega, ...	,,	½ to 2 tea-spoonfuls.

Uses.—The powder of senega taken as a snuff acts as a powerful irritant on the nose, causing cough, sneezing, and a discharge. In any form it acts similarly on the stomach as an irritant, more or less powerful according to the dose, large doses causing heat, pain, sickness, and diarrhœa. It similarly stimulates the lining membrane of the air-tubes after it has passed into the blood, increasing the quantity of blood flowing in it, and the secretion from it, and increasing cough by the increased irritability. It is therefore used in the later stages of bronchitis when the spit is abundant, but ought not to be used in the inflammatory stage of any lung affection, which it can only aggravate. It probably increases the strength of the heart, and consequently in congestion of the lungs because of failure of the heart and threatened blocking of the lungs, it is of great value with carbonate of ammonia and tincture of digitalis.

Balsam of Peru is obtained from a tree, *Myroxylon Pereiræ*, growing in the state of San Salvador in Central America. The bark of the tree is beaten with a blunt instrument until it separates from the trunk without breaking off. After a few days the loosened bark is charred by torches, and in the course of a week the charred pieces fall off. From the bare trunk the balsam exudes and is licked up by rags applied to it, from which the balsam is afterwards obtained by boiling in water. The bark of the tree is not loosened all round, but only in strips, so that the vitality of the tree is not destroyed. On the following year the untouched strips are similarly treated. Thus an annual supply of balsam is got for thirty years, with the exception of once every five or six years, when the tree is untouched, in order that it may not be too soon exhausted.

Balsam of Peru,........ Dose, 10 to 30 drops mixed up with gum or white of egg.

Uses.—The balsam is a stimulant, specially to mucous membranes, stimulating stomach and bowels, as well as the heart and kidneys. It is for chronic bronchitis that it is most frequently given internally, in which it lessens the expectoration. It is also used in dysentery because of its stimulating action, and in other cases of discharge from mucous membranes, such as from the nose, ears, and genital organs. It is used in gleet. It is reputed also as an antiseptic and as destructive to parasites. It is much used in Germany for itch, being more agreeable than sulphur ointment. The person first takes a prolonged warm bath, soap being freely used. Thereafter the body and specially the parts affected are rubbed with 40 drops of the balsam, and this is repeated thrice daily for two days, when the cure is complete. It affords great relief in cases of itching (pruritus, see p. 323), being applied pure by means of a brush, and it is employed for ulcers and sores, chilblains, and sore nipples. An ointment for the destruction of lice is made with 20 parts of the balsam, 50 of olive oil, and 100 of petroleum.

Balsam of Tolu is obtained from the *Myroxylon Toluifera*, of New Granada. It exudes from the trunk of the tree after incisions have been made in the bark.

Balsam of Tolu,	Dose,	10 to 20 grains.
Syrup of Tolu,	,,	1 to 3 tea-spoonfuls.
Tincture of Tolu,	,,	15 to 30 drops.

Tolu balsam has an effect similar to balsam of Peru, and is used chiefly for cough mixtures, in cases of chronic bronchitis. It is not used externally to the same extent as the latter; but is an ingredient of compound tincture of benzoin or Friars' balsam, used for wounds. In the latter combination it is very useful as an inhalation for tickling cough and hoarseness. A tea-spoonful is poured on the surface of boiling water and the vapour inhaled.

Copaiba is an oleo-resin obtained from incisions made in the trunk of *Copaifera multijuga*, found chiefly in the valley of the Amazon.

Copaiba,	Dose,	½ to 1 tea-spoonful.
Oil of Copaiba,	,,	5 to 20 drops mixed with gum or yolk of egg.

Uses.—Copaiba is a stimulant to mucous membranes, causing warmth in the stomach, and irritation, sickness, &c., if used in too large quantities. It is excreted by the kidneys, bronchial tubes, and skin, the unpleasant characteristic smell being readily perceived from the patient. In course of being expelled by the organs named it exerts a healing and antiseptic effect upon their lining membrane. It is thus a useful expectorant in chronic bronchitis, especially if the discharge be foul-smelling. But it is chiefly used for affections of the genito-urinary organs; for which, however, it ought not to be employed if the kidneys are the seat of any inflammatory affection.

Cubebs, in doses of 30 to 120 grains, is employed in the same circumstances as copaiba.

Various other oils and resins have similar effects, such as **Ammoniacum** (dose:—10 to 30 grains), a gum-resin, exuding after puncture from the stem of *Dorema ammoniacum*, found in Persia and the Punjaub; **Galbanum,** a gum-resin derived from *Ferula galbaniflua*, of India and the Levant, of which the dose is 10 to 30 grains; **Turpentine, Camphor, Benzoin.**

Benzoin is a gum-resin obtained from a tree —*Styrax Benzoin* or Benjamin-tree—indigenous to Sumatra, Borneo, and Java, and cultivated in the first-named place to a considerable extent. It is also called Gum Benjamin. It derives its properties from the benzoic acid it contains to the extent of 10 to 20 per cent. Its chief preparation is Compound Tincture of Benzoin—Friars' balsam—which is used mainly for wounds.

Benzoic Acid is contained not only in gum benzoin, but also in balsam of Peru, balsam of Tolu, and storax. It is an ingredient in the compound tincture of camphor—paregoric elixir —and the ammoniated tincture of opium. When taken internally benzoic acid creates a feeling of heat in the throat and of general warmth. It stimulates the lining membrane of the air-passages; and is used in chronic bronchitis, tending to diminish the excessive secretion. It also excites the secretion of urine, and stimulates the lining membrane of the bladder, being used in cases of chronic inflammation. Its dose is 10 to 15 grains.

Storax, a liquid balsam derived from the *Liquidambar orientalis*, is contained in the compound tincture of benzoin. Its actions and uses are similar to those of balsam of Peru. It is, like it, used for itch in the form of an ointment, of 1 oz. of storax and 2 drachms of olive-oil. After a warm bath the whole body except the head is rubbed with this, and one application is usually enough, but a second had better be given in twenty-four hours. It is not irritating to the skin, and this is a great advantage. It is used internally in chronic colds, especially of the lungs, but also of the urinary organs, in doses of 5 to 20 grains.

Myrrh, a gum-resin exuding from the stem of *Balsamodendron Myrrha*, of Arabia Felix and Abyssinia, is also used under like circumstances. Its dose is 10 to 30 grains. Of it there is a tincture (dose ½ to 1 tea-spoonful), which is an admirable astringent as a wash for spongy gums or ulcerated throat. It is given in combination with iron and aloes in pill (see p. 859). All these substances are only employed very occasionally in chronic bronchitis with profuse discharge, and after acute symptoms have passed.

Tar (Pix Liquida) is obtained by the destructive distillation of various pines, *Pinus palustris* and *Pinus sylvestris*. The preparations of tar used in medicine are:—

Tar Pills, 20 drops of tar made into pills with flour.
Tar Water,..................Dose, 1 or 2 pints daily.
(A mixture of 1 part tar and 3 parts powdered pumice-stone well shaken for 5 minutes with 10 parts of water.)
Syrup of Tar,...............Dose, ½ oz.
Tar Ointment.

Uses.—Tar is a stimulant to the skin and mucous membranes. Its chief use is in skin diseases, for which the ointment is applied, or

the tar itself or oil of tar rubbed in on the affected patches, while tar pills or tar water or syrup are taken internally. It is also of value when employed as a soap. It is a stimulant also to the lining membrane of the air-passages, diminishing expectoration in chronic bronchitis and other chest affections, for which it is best used as vapour. A little tar is mixed with the twenty-fourth part of its weight of carbonate of potash and placed in a cup set in hot water over a night-lamp. The apartment is thus allowed slowly to be filled with the fumes, which are inhaled by the patient. The tar water may be used as an inhalation.

Oil of Birch-tar (Oleum Rusci) is used as an inhalation in chronic bronchitis: 10 drops are slowly converted into vapour by heat in a chamber in which the patient is.

Horehound, the leaves and tops of a perennial herb, *Marrubium vulgare*, of the labiate order, has long been a popular remedy in chronic cough and other affections of the air-passages, attended by much defluxion. It is stimulating, may be used as a tonic in dyspepsia, and also stimulates the skin and kidneys. In chronic rheumatism and in intermittent fever it has also been used. The infusion may be made with 1 oz. of horehound to 1 pint of hot water, and of this a wine-glassful is the dose. A syrup is made by adding sugar to the infusion.

Hyssop—*Hyssopus officinalis*, of the natural order Labiatæ—is another plant much used in domestic medicine, for purposes similar to those for which horehound is employed. A drachm of the herb to a pint of hot water yields an infusion, used as a tonic in dyspepsia, in chronic bronchitis, and as a gargle for sore-throat. It has also been employed in absence of the monthly illness.

Elecampane—the root of *Inula Helenium*, of the order Compositæ—was one of the most popular of ancient remedies. It was a domestic remedy for chronic bronchitis, dyspepsia, absence of the monthly illness, and in chronic eruptions of the skin. For these its stimulating properties made it sought after. It has recently been claimed for it that it could destroy the germ of consumption, the tubercle bacillus (p. 393). It is given as a decoction, made by boiling ½ ounce of root in 1 pint of water. The dose is from a half to one wine-glassful. It contains a substance, **inulin,** allied to starch.

Ipecacuanha has already been discussed on p. 852. It is well, however, to note here again its action so far as the lungs are concerned. It differs materially in action from senega, the balsams, myrrh, &c., already considered in this section, in this, that it aids the expulsion of discharge from the lung both by increasing the force of cough and by increasing the fluidity of the spit; but at the same time it does not excite but calms the circulation in the lungs. Now the other expectorants excite the circulation, and in any inflammatory conditions are apt to do mischief, and are, therefore, avoided. Ipecacuanha, however, from its reverse action, can with safety be employed even though acute inflammation be present, and is, indeed, in many such cases the appropriate remedy. It is very useful in the dry inflammatory stage of bronchitis, which it relieves by increasing the natural secretion of the parts and causing the irritable inflamed membrane of the air-passages to become moist.

Inhalations and Sprays are much employed in treating affections of the air-passages, as it has been shown that vapour of substances drawn into the lungs with the breath can penetrate to the inmost recesses of the lungs, and can also be absorbed from the lining membrane and pass into the circulation. There are various methods of employing substances by inhalation. The substance may be converted into vapour by the aid of dry heat, and the air of the apartment in which the patient is may thus be impregnated with the remedy, so that the patient inhales it without further trouble; or the material may be converted into vapour by means of boiling water, and the vapour inhaled along with the steam from the water. This can be done by means simply of a jug half filled with boiling water. The patient brings his mouth down to the opening of the jug, and a towel is arranged round the mouth and the edge of the jug to prevent escape of the vapour. The towel is so arranged that the nostrils are free, and the patient should inhale by the mouth, but breathe out by the nostrils. Instead of a jug, one of the various forms of inhalers in the market can be used (see Plate XIX. 3 and 4, and section on Medical and Surgical Appliances). Then the inhalation may be effected by means of a form of respirator. One of the best kinds is shown in Plate XIX. 2. It consists of a metal piece which fits over the mouth. The wall of the case is at one part double, and is perforated with small openings. The outer part of the double wall is movable on a hinge; and a piece of lint soaked in the medicated solution is placed between the two parts. The respirator is then fixed over the mouth, and air drawn through the soaked lint. In this case also the patient should inhale by the mouth and exhale by the nose.

Medicated solutions are also applied by means of spray producers (see Plate XIX. 1). The patient opens his mouth widely and the spray is directed to the throat, the patient inhaling at the same time. By this means the air-passages below the top of the windpipe do not receive nearly so much of the remedy, the back of the mouth and top of the gullet intercepting most of the material. Finally, remedies may be introduced into the air-passages in the form of smoke from a pipe, cigarette, or cigar, the remedy being mixed up with tobacco or used instead of tobacco.

The substances commonly employed in one or other of these ways may be either stimulating or soothing, or may be employed chiefly for antiseptic properties to destroy a foul smell, in cases where the expectoration is fœtid, or for astringent purposes for relaxed throat or hoarseness, or to control bleeding from the throat.

Stimulating and Antiseptic Inhalations.

Vapour of Carbolic Acid.
,, Creasote.
,, Benzoin.
,, Iodine.
,, Pine Oils.
Spray of Sulphurous Acid.
Vapour of Tar.
,, Turpentine.
,, Terebene.
,, Oil of Thymol.

Soothing Inhalations.

Vapour of Water.
,, Conium.
,, Nitre, as Nitre Paper.
,, Stramonium.
,, Tobacco.
Spray of Ipecacuanha Wine.

Astringent Sprays.

Alum Spray (10 grs. to 1 oz. water).
Sulphate of Iron Spray (2 grs. to 1 oz. water).
Lactic Acid Spray (21 grs. to 1 oz. water).
(For use in diphtheria.)
Tannic Acid Spray (60 grs. to 1 oz. of water).
(For bleeding.)

Carbolic Acid and Creasote are used as inhalations with the Coghill inhaler, already mentioned, in chronic bronchitis, and also in consumption, in both of which they are very useful. The strength of carbolic acid is 60 drops to 1 ounce of water, and of this 10 drops are placed on the lint of the inhaler. A solution of spirit of creasote of the same strength may be used, or 12 drops are placed on 8 oz. of boiling water. Creasote and carbolic acid may be mixed, 60 drops of each, 2 drachms of glycerine, and 1 oz. of water, of which use 10 drops.

Compound Tincture of Benzoin is used for hoarseness and in chronic bronchitis. A teaspoonful is poured on the surface of boiling water.

Iodine is employed in cases of offensive spit, and in chronic bronchitis. Thirty drops of tincture of iodine are mixed with 4 ounces of cold water, and the vapour is cautiously inhaled.

Turpentine and Pine Oils are the most commonly used of inhalations in cases of chronic bronchitis with excessive expectoration, and as antiseptics in cases of consumption. It has been asserted that the atmosphere of pine forests is extremely beneficial in lung affections, and the use of such an inhalation is an attempt to create an artificial atmosphere of the same kind. One ounce of turpentine to 5 ounces of cold water are used with a common inhaler. **Terebene,** prepared from it, may be used with the Coghill inhaler, 10 drops being placed on the lint. Of pine oils the oil of *Pinus sylvestris* (for wood oil) and *Pinus pumilio* are employed in a similar way, or may be used with boiling water as follows:—40 drops are mixed with 20 grains of carbonate of magnesia, and that with 1 ounce of water. One drachm (60 drops) is placed on hot water and inhaled.

Oil of Eucalyptus—the Blue Gum-tree—is used for inhalation. Ten drops on boiling water may be inhaled, or 5 to 10 drops may be placed on the lint of the Coghill inhaler, or it may be similarly used when mixed with terebene, in equal proportions. It is also given internally in chronic bronchitis and consumption as tincture, of which 15 to 60 drops are a dose, or in emulsion with mucilage of ordinary gum or gum tragacanth, 2 drops of the oil being the dose.

Sulphurous Acid Spray is employed chiefly for sore throats, hoarseness, &c. The strength employed is 5 drops sulphurous acid to 1 ounce of water.

Oil of Thymol is employed for antiseptic purposes, 10 grains being mixed with 20 of magnesia and 3 ounces of water, one drachm being inhaled from hot water.

REMEDIES WHICH SOOTHE THE LUNGS AND AIR-PASSAGES.

Remedies which Lessen the Circulation in the Lungs.

Nothing so quickly allays irritability of the lungs and air-passages as a diminution in the quantity of blood flowing through them. This diminution is not to be effected by creating

difficulties to the flow of blood. On the contrary, everything which, by dilating the blood-vessels for example, permits the blood to flow more easily, will afford relief. What is desired, however, is the withdrawal of the blood to some other part of the body, and so getting rid of determination of blood to any particular part of the respiratory system, which is the first stage of inflammation. The chief means of effecting this are (1) heat, and (2) counter-irritation, that is the use of mustard poultices or blisters. For example, a mustard foot-bath would produce speedily relief, or a large hot poultice applied to the back or chest. A mustard poultice speedily reddens the skin, that is, withdraws blood to the surface, and a blister has a similar effect, its action being less fleeting. Heat may be applied directly to the air-passages in the form of steam. The inhalation of the steam of hot water from a jug will act by causing dilatation of the vessels of the upper air-passages, and will thus aid the onward progress of the blood. The steam may be poured into the apartment occupied by the patient by means of a bronchitis kettle (see Plate VIII.). Brisk purgatives, by taking the blood down to the bowels, will relieve the circulation in the lungs. For this purpose saline purgatives are best, since they also promote secretion of liquid mucus, and aid expectoration.

A second way of lessening the circulation is by the use of remedies which diminish the force and frequence of the heart, such as aconite (p. 834), antimony (p. 853), and ipecacuanha. The advantage of ipecacuanha has already been noted above, in that while depressing the circulation it increases the secretion of mucus, and strengthens the expulsive effort.

It is important also to note that rest and complete cessation of all muscular effort is an important aid to treatment designed to remove irritability of air-passages. It is common, for example, to observe how the slightest movement will cause certain kinds of cough to recommence immediately. Patients often recognize this fact by endeavouring to restrain to the utmost even the necessary movements of breathing.

Remedies which Diminish Expectoration.

The natural method of diminishing expectoration is by the removal of the condition which occasions it. This means the cure of the chronic bronchitis, &c., of which the expectoration is simply one of the consequences. Sometimes, however, in chronic cases when the quantity of expectoration is excessive, one is inclined to ask can nothing be done to diminish its bulk. The best treatment would be the administration of acid tonics, of which a list is given on p. 841. Acids have an undoubted effect in "drying up" the secretion.

Atropine, the active principle of belladonna (see section on Drugs Acting on the Nervous System), also acts to some extent in the same direction. Anyone taking belladonna or atropine is certain to complain of an excessive dryness of the mouth and throat, due to the diminished secretion from the glands of the mucous membrane. For this purpose from the $\frac{1}{120}$th grain to $\frac{1}{80}$th grain of atropine, or 5 drops of tincture of belladonna, might be taken several times daily. It is to be observed, however, that atropine and belladonna also act upon the nerves of the respiratory organs, quieting them. The efforts to expel the expectoration would, therefore, be lessened, and there would be the risk of the material accumulating in and blocking the lungs. It would, therefore, be well to combine the atropine with a stimulant, such as ammonia or senega, in the hope that there would be diminished secretion but increased expulsive effort.

Remedies which Relieve Spasm of the Air-passages and Cough.

This class of remedies and that of expectorants are the most important so far as the respiratory system is concerned. We have already referred to the fact that a prominent feature of the smaller bronchial tubes is the layer of muscular fibre in their walls, by whose contraction the passage is very much narrowed if not obliterated. In such a condition existing to any extent in the lung there would be great difficulty of breathing, from the greater or less degree of closure of the tubes. Such a state of affairs exists in spasmodic asthma. The muscular layer contracts because of stimulation reaching it along nerves, and the irritation of the nerves ending in the spasm may arise in the lungs themselves, or may exist in some other organs. Thus acidity of the stomach or some congestive condition of the liver will sometimes determine an attack of asthma. Again the irritation may be applied to the nerve centre for respiration (p. 257), and may be due to the character of the circulating blood, as in gout and rheumatism. A similar kind of spasm is that by which the opening in the larynx—the chink of the glottis—is closed, such as occurs in child-crowing. The second kind of spasm it is

necessary to soothe is that which manifests itself chiefly in cough. Whooping-cough is essentially of a spasmodic character. In many instances, owing to the extreme irritability of the nerves of the air-passages, the slightest irritation, whether by breathing cold air, or the inhalation of dust, or irritation of the stomach, or irritation of the nose, as is often present in the form of polypus, is sufficient to set up a dry hacking cough. This is a kind of spasm also to be relieved by soothing remedies. The chief of such remedies are lobelia, stramonium, belladonna, hyoscyamus, tobacco, conium, as well as general sedatives like opium. It should not be forgotten, however, that the best remedy for spasm may often be some substance which may at first increase the spasm, such as ipecacuanha, by increasing the cough, but will speedily get rid of it by expelling the phlegm or other material whose stay in the air-passages is the cause of disturbance. Similarly an emetic may sometimes be the best remedy, by emptying the stomach and mechanically clearing the air-passages at the same time.

Lobelia.—The leaves and tops of *Lobelia inflata,* native to North America. The herb is also called Indian tobacco. Its preparations are:

Tincture of Lobelia,[1]............Dose, 10 to 30 drops.
Etherial Tincture of Lobelia,... ,, 10 to 30 drops.

Uses.—In large doses lobelia causes burning pain, vomiting, and purging, acting as an irritant poison, and great prostration, headache, and giddiness result, and, in poisonous doses, failure of the heart and breathing. The remedy for this state of things is strong stimulants after the stomach has been emptied. It is chiefly employed in spasmodic asthma, being given in 10-drop doses while the fit is on, repeated every ten minutes till sickness is produced. In bronchitis, with a tendency to spasm, it is given in 10-drop doses with ammonia, senega, or other expectorants.

Stramonium, or Thorn-apple (Plate XII.), is discussed on p. 900. Its chief use is for nervous asthma, for which it is employed by mixing 15 grains of the dried leaves, or 7 of the fibres of the dried root, with sage leaves or tobacco and smoking it in a pipe or cigarette, inhaling the smoke. The leaves of *Datura Tatula,* a plant of the same genus, may be used instead of those of *D. Stramonium.*

Belladonna, hyoscyamus, and tobacco are discussed in the section devoted to Drugs Acting on the Nervous System. The value and use of belladonna in whooping-cough have been referred to on p. 417.

Conium maculatum or Spotted Hemlock (Plate XI.) is used chiefly in the form of vapour as an inhalation to relieve cough in bronchitis, consumption, and whooping-cough (see p. 903).

Vapour of Hemlock (extract of hemlock 60 grains, solution of potash 1 drachm, water 10 drachms; mix.) Put 20 drops on a sponge in an inhaler containing hot water.

Nitrite of Amyl has been referred to as valuable in asthma on p. 837, and the inhalation of the fumes of nitre paper on p. 274.

Remedies for Cough have been stated at sufficient length on p. 284. One need only insist here on the fact that very frequently the best remedy for cough is some means which will loosen phlegm and permit of its ready expulsion, such as warm drinks, warm applications, and expectorants like ipecacuanha. The constant hacking exhausting cough, with little spit or none at all, demands, however, some soothing remedy. Inhalations of steam will help, and probably some actively soothing drug will be necessary, of which the best is one of the preparations of opium. (Refer to opium in the section relating to Drugs Acting on the Nervous System.)

Of popular remedies for cough, horehound (p. 882), marsh-mallow and colt's-foot are the chief.

Marsh-mallow (*Althæa officinalis,* natural order Malvaceæ) is a perennial herb, common to the greater part of Europe and naturalized in America, growing in marshy places near the sea. The root is chiefly used, but the leaves and flowers also. The root, collected in early spring or autumn, is dirty white externally and pure white within. It has a faint aromatic odour and a sweet mucilaginous taste. It is employed for its soothing effects on irritable inflamed surfaces. Poultices of the bruised root are employed to relieve inflammations of the skin. An ointment may be made by boiling the cut fresh leaves with lard for half an hour and then straining. In psoriasis of the hand it has proved effective. The ointment of the shops is used for irritable sores. In sore-throat marsh-mallow lozenges are exceedingly soothing. One kind of such confection is the *pâté de guimauve.* For irritable cough this or the syrup may be used. The syrup is made thus:—Of the dried and sliced root $1\frac{1}{2}$ ounces are steeped in 1 pint of cold water for twelve hours. The

[1] The American tincture is weaker; of it the dose is 30 to 120 drops.

liquor is then pressed out and strained through muslin. To the liquor twice its weight of sugar is added and the whole dissolved by a gentle heat. When the syrup is cold, add half a drachm of rectified spirit to each ounce. The dose is from a tea-spoonful to a table-spoonful.

Many varieties of mallow are used in a similar way.

Colt's-foot (*Tussilago farfara*, of the natural order Compositæ) is also a perennial herb, common in Europe, Asia, and America, growing in damp soil, in ditches, and along brooks. An infusion is made (1 ounce of dried leaves and flowers to 1 pint of hot water) for coughs and chronic bronchitis; and of it a tea-cupful may be taken at a time. The smoke of the burning root is inhaled in chest affections, and the root is also smoked in a pipe for lung affections.

Liquorice, Spanish-liquorice, the root and underground stem of *Glycyrrhiza glabra*, of the order Leguminosæ, is employed in cough and irritable conditions of the air-passages, because of its bland and soothing properties. It is also added in powder because of its sweetness to several preparations, such as the preparation of senna (p. 857). A fluid extract is prepared, and there is also the well-known dry extract, in sticks. It is often associated with linseed to yield a soothing drink for irritable states of the air-passages. Such a preparation is the infusion of linseed, made as follows:—

Linseed,...............................	160 grains.
Fresh liquorice root, sliced,....	60 grains.
Boiling water,......................	10 ounces.

Infuse 4 hours and strain. One to two ounces of this is a dose.

SECTION VI.—DRUGS WHICH ACT UPON THE SKIN.

Drugs which Increase the Amount of Sweat—Diaphoretics and Sudorifics:
- *Acetate of Ammonia;*
- *Dover's Powder—Ipecacuanha and Opium;*
- *Camphor and Antimony;*
- *Jaborandi and Pilocarpine.*

Remedies for Excessive Sweating:
- *Belladonna and Atropine*—Their Use in the Night-sweats of Consumption;
- *Oxide of Zinc;*
- *Acids and Acid Sponging.*

Drugs which Improve the Nutrition of the Skin:
- *Iron, Arsenic, &c.;*
- *Sassafras; Woody Nightshade (Dulcamara); Burdock; Rhus Toxicodendron (Poison Oak).*

There are a great many remedies applied to the skin to produce merely local effects, such as ointments, washes, &c., and others for the purpose of acting upon deeper organs, such as stimulating liniments, blisters, and so on. These remedies it is not our purpose to discuss here. They are considered in a later section on Remedies for External Application. Here we wish to note the chief remedies employed to act upon the skin as a whole. The skin, as we have seen, has two main functions (see Section XI. A. p. 306): first an excretory function, by removing water with a small portion of salts in solution; and second, and perhaps the more important function, that of regulating the temperature of the body. The excretory function is effected entirely by the glands of the skin, but their activity may be stimulated by nerves, or, without any nervous stimulation reaching them directly, they may be excited to more vigorous action by an increased flow of blood to them owing to dilatation of the blood-vessels of the skin. The regulation of the body heat, however, may be affected both by the activity of the glands and by the activity of the circulation, together, or by one apart from the other. Thus dilatation of the blood-vessels of the skin and an increased flow of blood in the skin might exist apart altogether from any increased activity of the glands, and there would be an increased loss of bodily heat from the exposure of a greater quantity of blood to the external air. On the other hand increased sweating might occur, owing to nervous excitement, even when the quantity of blood flowing in the skin was less than usual. We know the sudden outburst of sweating that occurs in some people with fear, even when the marked pallor of the skin indicates contracted blood-vessels, and how, when a person is rallying from a threatened faint, beads of perspiration stand upon the forehead in curious contrast to the paleness of the face. The functions of the skin, then, may be altered by remedies (1) which affect the circu-

lation in the skin, and (2) which act upon the glands. It appears that the glands may be acted upon in more ways than one. They are supplied with nerves, and there are some drugs, notably pilocarpine, which stimulate the nerve terminations in the cells of the glands and thus excite increased secretion, while atropine, the active principle of belladonna, has a reverse effect, paralysing the nerve terminations so that secretion is arrested. Other drugs excite not the nerve terminations in the glands, but certain parts of the central nervous system which are in communication with the glands. Thus in the upper part of the spinal cord there is believed to be a centre presiding over sweating, the exciting of which will cause an increase of sweating in the upper extremities, while a similar centre exists low down in the spinal cord, stimulation of which causes increase of sweating in the lower extremities. The condition of the blood affects these centres, exciting them if the oxygen of the blood be deficient; and nicotine, the active principle of tobacco, excites them also. Through these centres, by a reflex action (p. 86), impressions affecting sensory nerves throughout the body may affect the amount of sweating. In this way severe pain acts in causing sweating and sickness. It is also through these centres that mental emotions cause increase or diminution of the amount of perspiration.

Drugs which Increase the Amount of Sweat.

Drugs which increase the perspiration are called **diaphoretics** or **sudorifics**, according to the extent of the increase. Diaphoretics (Greek *diaphoreo*, to carry across) are drugs moderately increasing the sweat, and sudorifics (Latin *sudor*, sweat, and *facio*, I make) is the term applied to drugs with more powerful action, when the perspiration streams from the surface.

Heat is one of the simplest means of acting upon the skin to promote sweating. This it does by dilating the blood-vessels of the skin and increasing the activity of the circulation. Warm air, warm clothing, the warm bath, and warm spiced drinks, all these are well-known means of accomplishing the purpose sought. Alcohol has a similar effect, relaxing the blood-vessels of the skin and promoting a feeling of warmth, though actually cooling the skin by increasing the loss from the surface.

The chief sweating drugs are:—

Solution of Acetate of Ammonia (Mindererus' Spirit).
Dover's Powder (Ipecacuanha and Opium).
Camphor. Antimony. Pilocarpine.

Solution of Acetate of Ammonia (p. 843), when given internally, acts on the skin, if the body be kept warm, and on the kidney if the skin be kept cool. Its dose is from 2 to 6 tea-spoonfuls. It is one of the mildest and safest of sweating remedies, peculiarly suitable for children, used in fevers, those attended by rash, and feverish colds, and when fever is present from other causes, as in inflammation of the lungs. It soon makes the dry hot skin pleasantly moist. It is usefully combined with spirit of nitrous ether to act upon the kidneys (see next section). The drug acts apparently upon the cells of the sweat glands, as well as dilates the blood-vessels of the skin.

Dover's Powder, the compound powder of ipecacuanha and opium (see p. 852), is one of the most commonly used of sweating powders. Its dose for an adult is 10 grains; and it should not be given to children. Its effect in the early stage of cold-in-the-head, or influenza-cold is remarkable, if it be taken soon enough. It commonly dispels the dull headache, the pains in the bones, and the sickness, as if by magic. The person ought to take the powder, use a footbath, get into bed, and have a warm drink; and then the beneficial effects are speedily felt. Ipecacuanha itself acts upon the skin, and may be given as powder, or as the wine, to children; and opium alone, or any of its preparations, also increases sweating (see Section VIII.), but they are best given in combination, except in the case of children.

Camphor (see p. 850) and other aromatic substances increase the production of sweat. Camphor is specially employed in cases of catarrh or cold-in-the-head in 2 or 3 grain doses, or as the spirit of camphor and as vapour.

Antimony was at one time much used for this purpose in the form of James' Fever Powder (p. 853), but is little employed nowadays.

Pilocarpine is an alkaloid derived from the dried leaflets of *Pilocarpus pinnatifolius*, or *Jaborandi*, a plant found in South America. Of jaborandi there is an extract (dose: 2 to 10 grains), an infusion (dose: 1 to 2 fluid ounces), and a tincture (dose: $\frac{1}{2}$ to 1 tea-spoonful), and in America a fluid extract of pilocarpus is obtained (dose: 5 to 60 drops). Of the alkaloid pilocarpine itself the dose is $\frac{1}{20}$ to $\frac{1}{2}$ grain, as nitrate or muriate (hydrochlorate) of pilocarpine.

Uses.—If a dose of from $\frac{1}{20}$ to $\frac{1}{3}$ grain of the muriate of pilocarpine be injected under the skin of a person, it produces in a few minutes flushing of the face and breast, and sweat appears first

on the forehead and in the arm-pits and then over the whole body. Saliva is increased, the tear glands become more active, and the secretion of wax in the ears and of mucus in the throat and nostrils is increased. The gastric glands and intestinal glands are sometimes excited, and diarrhœa sometimes occurs; while the kidney is stimulated, and the flow of milk in the breast glands is sometimes, though not always, augmented. By irritation of the stomach it sometimes causes sickness and vomiting. The pulse is increased, and vision becomes indistinct by contraction of the pupil. It produces, sometimes even in small doses such as that named, unpleasant symptoms, such as palpitation, giddiness, retention of urine and strangury, and collapse, and it brings on in women the monthly flow. These bad effects can be arrested by the use of atropine. It is chiefly used in dropsy to promote removal of the accumulation of water, which it is well fitted to do, since in a few hours the body may lose eight pounds weight from the combined sweating and flow of saliva. It is found useful in arresting convulsions dependent upon kidney disease. The enormous loss of water from the body it occasions has been found to promote the cure of pleurisy with effusion by withdrawing fluid from the chest-cavity. In asthma and bronchitis with much expectoration it has yielded benefit, and it has cured a persistent case of hiccough which resisted all other treatment. It has also been employed to promote sweating in fevers and feverish colds, and in itching skin diseases; and it has been employed, but without much success, in eye diseases, specially in separation of the retina, from the notion that it might remove the fluid beneath the retina which is the cause of the detachment. Pilocarpine is an antidote to poisoning by belladonna and *vice versa.*

Remedies for Excessive Sweating.

The chief remedies for excessive sweating, that is drugs which diminish the secretion of sweat, are belladonna, and its active principle atropine, and zinc.

Belladonna and **Atropine** are discussed in Section VIII. It is well to note here, however, the powerful effect they have in diminishing sweating. When belladonna is taken internally the throat and skin are both dry. The effect upon both is due to a paralysing influence upon the secreting cells of the glands. The secretion of saliva can be completely arrested by the drug, owing to the paralysis of the cells. It is, therefore, a most valuable drug whenever any such effect is desired. Thus in the night-sweats of consumption a pill of the extract of belladonna, $\frac{1}{2}$ to 1 grain, or $\frac{1}{200}$ grain of atropine is often sufficient. The excessive sweating of acute rheumatic fever may be similarly arrested. When the sweating complained of affects only one part of the body, say arm-pits, feet, &c., the remedy may be employed as a paint to the part in the form of the extract made somewhat thin with glycerine, or the tincture may be rubbed in as a lotion. It is a similar action which makes belladonna very useful for diminishing or arresting the flow of milk from the breast. It should be applied as a paint of the extract, and the breast covered with a square of lint, a piece being cut out of the centre for the nipple.

Zinc Salts, specially the oxide of zinc, 1 to 3 grains in pill, are also valuable in excessive sweating. A pill of

2 grains oxide of zinc,
$\frac{1}{8}$ grain belladonna extract, and
$\frac{1}{4}$ grain extract of nux vomica,

given at bed-time, is likely to be sufficient to check the night-sweats of consumption.

Acids, especially the dilute aromatic sulphuric acid in doses of 10–20 drops in water, are employed successfully to check the sweats of consumption. Any of the dilute acids mentioned on p. 841, freely diluted with water, and used to sponge the surface of the body, will often effectually control excessive perspiration.

Drugs which Improve the Nutrition of the Skin.

There are numerous drugs which act upon the skin, not in any obvious manner, and without so markedly influencing the perspiration as the two classes of drugs which we have considered already in this section, but by gradually improving the nutrition of the skin. They are such drugs as we have considered in Section I., which imperceptibly modify the chemical changes going on in the tissues, and ultimately induce healthier action, namely:—Iron (p. 817), arsenic (p. 823), sulphur (p. 827), sarsaparilla (p. 828), guaiacum (p. 828), mezereum (p. 829). The last four act as stimulants to the circulation in the skin, and thereby also increase the action of the glands. Senega, although it is chiefly used as a stimulant to the air-passages (p. 880), has a like effect upon the skin, thereby promoting the action of the skin. Serpentary (p. 841) may be grouped along with these for its stimulating effect upon the circulation in the small blood-vessels.

Sassafras, the dried root of the sassafras

tree (*Sassafras officinalis*), growing in the United States and Canada, is sometimes used in cases of chronic skin diseases, such as those for which sarsaparilla, guaiacum, &c., are employed. It is a stimulant to the skin, and was formerly used in chronic diseases of the skin and in syphilis, the popular belief being that it "helped to purify the blood." It increases also the action of the kidneys.

Dulcamara, Woody Nightshade, or Bittersweet, the dried young branches of *Solanum Dulcamara*, is another remedy which improves the condition of the skin, and has long been used as a popular remedy for scaly diseases of the skin, psoriasis, eczema, acne, and others. It has also been employed in chronic bronchitis and other lung affections. It can act, however, as a poison, slowing the heart and breathing, and causing death with convulsions. Of the infusion of dulcamara the dose is 1 to 2 fluid ounces. The infusion is made with 1 ounce bruised dulcamara and 10 ounces boiling water infused one hour and strained.

Burdock, the root of *Lappa officinalis*, of the Compositæ order, has long had a popular reputation for the cure of chronic skin diseases, as well as for rheumatism, gout, scrofula, chest affections, &c. It is used both as an internal medicine, and for outward application. For the former a decoction is made by boiling 2 ounces fresh-bruised root in 3 pints of water down to 2 pints. A pint of this should be taken daily. Another preparation is made by adding 1 pound of ground burdock seed to a gallon of whisky, letting it stand for two weeks, and then decanting. Of this 2 or 3 tea-spoonfuls are taken after meals. The fresh leaves bruised, the juice from fresh leaves, and lotions made by boiling the leaves or root with oil, are used for ulcers, wounds, and various other skin affections.

Rhus Toxicodendron—Poison Oak, Poison Ivy—is a plant belonging to the natural order Terebinthaceæ, to which also the **Common Sumach** (*Rhus glabra*) and the **Sweet Sumach** (*Rhus aromatica*) belong. It is indigenous to Canada and the United States. The emanations of the living plant and the juice of the fresh leaves produce an eruption on the skin attended by itching, swelling, pain, and fever. For this lime-water or lead lotion is a good application. A tincture is prepared of which the dose is 1 to 5 drops in water thrice daily. It has been recommended in chronic skin affections, in rheumatism, in incontinence of urine due to weakness of the bladder, and in paralysis dependent upon concussion of the spine. The tincture is known by the author to have been taken internally by a person who was very much annoyed by the growth of warts on the fingers, and with perfect success, the warts completely disappearing after some time. There seemed little doubt that the drugs exerted some special action on the nutrition of the skin. It is for this reason he deems it proper to give the remedy a place in this section.

The common and the sweet sumach have both been used for their astringent properties as gargle, and for application to wounds, and also internally as a tonic to the bladder. An infusion of leaves or bark, 1 oz. to 20 of water, may be used.

SECTION VII.—DRUGS WHICH ACT UPON THE KIDNEYS, BLADDER, AND GENERATIVE ORGANS.

Drugs which Increase the Quantity of Urine—Diuretics:
Water and Watery Drinks;
Salts of Potash and Soda;
Ammonia; Digitalis; Squill;
Sweet Spirit of Nitre;
Broom-tops; Juniper; Copaiba; Hops; Pareira; Buchu; Bearberry;
Chimaphila; Dandelion.

Remedies which Soothe the Kidneys.

Drugs which Stimulate the Bladder.

Drugs which Allay Irritability of the Bladder.

Drugs which Act on the Generative Organs:
Pennyroyal, Savin, and Rue;
Black Snake-root (Cimicifuga); Blue Cohosh (Caulophyllum);
Pulsatilla and Beberine.

DRUGS WHICH ACT UPON THE KIDNEYS.

The chief object desired from drugs, given to act upon the kidney, is to increase the flow of urine. This result may be sought because the flow is scanty, or because of some disease of the

kidney or bladder, or, while the urinary organs are healthy, they may be stimulated in order to effect the removal of some dropsical accumulation of fluid in some part of the body, or the kidney may be stimulated in conditions of fever in order to aid in diminishing the fever, and to sweep out of the body waste materials which the fever has produced. Drugs which have the effect of increasing the flow of urine are called **diuretics** (Greek, *dia*, through, and *oureo*, I pass water). It is necessary, however, to observe, that drugs which increase the activity of the kidney, and increase the quantity of water produced by them, are not always the appropriate remedy when there is a scanty flow of urine. A person, for example, may pass very little water at a time, or may be unable to pass water at all. It would be a very great mistake to give that person a dose of spirits of nitre, as is common, or gin, or some similar remedy, for the fault may not exist in the kidneys at all, which may be doing their work quite satisfactorily; the fault may be in the bladder which has lost the power to expel the urine, or which is prevented expelling the urine by some spasmodic condition of the neck of the bladder, or some inflammatory swelling which obstructs the flow of urine. Under these circumstances to give medicine which would increase the flow of urine into an already full bladder, would only be greatly to add to the uneasiness, discomfort, and pain which the person is suffering. What is evidently needed is some means of emptying the bladder. The relation between the kidney and bladder is set forth in Part I., Section X. A. p. 288, where it is explained that the urine, secreted in the kidneys, is passed down the ureters, a fine tube leading from each kidney to the bladder, and that the urine flows into the bladder constantly, but drop by drop. When the bladder is full, owing to a nervous action the muscle guarding the neck is relaxed, and the urine expelled by the contraction of the muscular walls of the bladder (see p. 294). The distinction then between the secretion of urine by the kidney and its expulsion by the bladder must never be forgotten. It is only in the cases where it is desired to act upon the kidney that diuretics are given.

Drugs which Increase the Quantity of Urine.

The following is a list of the chief drugs which increase the quantity of urine:—

Water in large quantities.
Aerated waters.
Acetate, citrate, nitrate, and bicarbonate of potash.
Bicarbonate and phosphate of soda.
Citrate and carbonate of lithia.
Ammonia, Digitalis, Squill, } By strengthening the heart.
Nitrous ether.
Broom-tops.
Juniper.
Copaiba.
Hops.
Pareira.
Buchu.

Of water and aerated waters it is not necessary to say much. All watery drinks increase the quantity of urine, because the water is absorbed from the stomach and passes into the blood, and is speedily excreted by the kidneys. If one drinks, while fasting, several glasses of spring water, one after the other, at intervals of 15 or 20 minutes, after the second or third glass, water will be passed less coloured than usual and in quantity very nearly equal to the first glass. If one goes on drinking, the urine will keep pace with the water imbibed, and after many glasses will be little different from spring water. This clearly would produce a flushing-out action on the kidneys and bladder, and would also remove much waste material from the body, being beneficial in gouty conditions and as a preventive of gravel. In many cases of inflammation of the kidney, where one wishes to pass a larger quantity of water through the kidney without irritation, water and watery drinks, milk with aerated waters, are very suitable.

The saline substances in the above list—acetate, citrate, &c., of potash, and the salts of soda and lithia—have been noted elsewhere (pp. 818, 819). These are capable of acting both on the bowels and the kidneys, at least the salts of soda and potash are, and very often the relief they produce by their action on the bowels has a very beneficial effect on the kidney. In feverish conditions they are useful. The salts of potash are commonly given along with the sweet spirit of nitre in dropsy; they and the soda salts are commonly used when it is desired to diminish the acidity of the urine, and lithia is specially given for such purposes in gouty and rheumatic conditions.

Ammonia, digitalis, and squill all act upon the kidney indirectly by their tonic action upon the heart and blood-vessels. Whenever dropsy with scanty, high-coloured urine is the consequence of feeble and irregular heart, digitalis is the remedy to be used (see p. 832), though it is usual also to combine it with the aromatic

spirit of ammonia or carbonate of ammonia (p. 843), to aid the stimulating action on the heart. When digitalis fails, the addition of squill (p. 833) helps to produce the desired effect, after the bowels have been relieved by blue-pill.

Spirit of Nitrous Ether—Sweet Spirit of Nitre—the dose of which is ½ to 2 tea-spoonfuls, is one of the most commonly used of remedies for increasing the quantity of urine. It relaxes the smaller blood-vessels of the skin and kidneys, thus allows a freer flow of blood through them, and causes a corresponding increase in the urine and sweat. It is familiarly used in feverish states, for this action that has been described results in cooling the body. It should not be used in acute disease of the kidney, because of its effect in promoting a fuller supply of blood to the kidney.

Broom-tops (*Scoparius*), the fresh and dried tops of the shrub *Sarothamnus scoparius*, abundant in Great Britain. It belongs to the leguminous order of plants, to which the pea and bean also belong. It contains a poisonous alkaloid, **spartein**, and another principle called **scoparin**. Its preparations are:—

	DOSE.
Decoction of Broom-tops, ...	1 to 3 fluid ounces (2 to 6 table-spoonfuls).
(1 oz. dry tops, 1 pint water; boil 10 minutes and strain.)	
Juice of Broom-tops, ...	1 to 2 tea-spoonfuls.

Broom-tops are used only for their action on the kidneys. They are employed in cases of dropsy due to chronic disease of the kidney, usually along with digitalis or acetate of potash. The active principles of the drug appear to excite the secreting cells of the kidney, and on this account, while it is useful in chronic disease, it is hurtful in acute disease of the kidney, where soothing treatment is desired.

Juniper, the fruit of *Juniperus communis*, a shrub 4 to 6 feet high, whose fruit—juniper berries—is berry-like in appearance. Its preparations are:—

	DOSE.
Oil of Juniper (distilled from the fruit),.........................	1 to 4 drops.
Spirit of Juniper,....................	30 to 60 ,,
Compound Spirit of Juniper,....	2 to 4 tea-spoonfuls.
(Contains oils of juniper fennel and caraway, and alcohol.)	

Uses.—Juniper is contained in gin and hollands, and it is because of its virtues that these are recommended to increase the quantity of water. Its action resembles that of turpentine. It acts as a stimulant to the stomach, expels wind, and relieves spasm. It directly stimulates the kidney, increasing the urine, but if given in excessive doses causes inflammation and strangury.

Copaiba (see p. 881) is sometimes used in dropsy, dependent upon affection of the liver or heart; but its irritating properties render it liable to do harm if the kidneys are diseased. Its chief use is for catarrhal conditions of the bladder and urinary outlet.

Hops act slightly upon the kidneys, and beer possesses such a property on account of their presence. Besides the infusion mentioned on p. 841, there is a tincture, of which the dose is ½ to 2 tea-spoonfuls.

Pareira Root—Pareira Brava—the root of *Chondodendron tomentosum*, a woody climber of Brazil and Peru, known as *Cissampelos abutua*. Its preparations are:—

Powdered Pareira Root, ...	Dose, 30 to 60 grains.
Decoction of Pareira,................	,, 1 to 2 ounces.
(Sliced root 1½ oz., water 1 pint; boil 15 minutes, strain. Add water to make a pint.)	
Infusion of Pareira, ...	Dose, 1 to 2 ounces.
(1 oz. bruised root, 1 pint boiling water; infuse 2 hours.)	
Extract of Pareira, ...	Dose, 10 to 20 grains.
Liquid Extract of Pareira,	,, ½ to 2 tea-spoonfuls.

Uses.—Pareira is a bitter tonic. It stimulates the kidney, increasing the flow of urine. It is also a stimulant to the mucous lining of the urinary passages; and it is in chronic catarrh of the bladder that it is most commonly used, when it promotes healing and lessens the discharge.

Buchu Leaves are the dried leaves of *Barosma betulina*, *crenulata*, and *serratifolia*, three shrubs belonging to the order Rutaceæ, indigenous to Cape Colony. Its preparations are:—

	DOSE.
Infusion of Buchu,...................	1 to 2 ounces.
(Infuse 1 oz. of the leaves for 1 hour in 20 ozs. boiling water and strain.)	
Tincture of Buchu, ...	1 to 2 tea-spoonfuls.
Liquid Extract of Buchu, ...	20 to 45 drops.

Buchu is used chiefly as infusion, and for the same purpose as pareira root. It is a tonic, exciting a feeling of warmth in the stomach, quickens appetite and digestion, and is used in South Africa in doses of 20 grains of the powdered leaves for similar effects on the bowels in cases of diarrhœa and dysentery. It acts on the kidneys and bladder as a stimulant, and is often used with infusion of bearberry leaves (*uva ursi*).

Bearberry Leaves, the dried leaves of *Arctostaphylos uva ursi*, a trailing evergreen shrub of the order Ericaceæ, growing in most

parts of Europe, Northern Asia, and North America. Its preparations are:—

Infusion of Uva Ursi,............ (1 oz. leaves, 20 ozs. boiling water, infuse 2 hours and strain.)	Dose, 1 to 2 ounces.
Fluid Extract of Uva Ursi,......	„ 30 to 60 drops.

Bearberry leaves contain tannic and gallic acids, and are therefore astringent. It also contains a principle called **arbutin**, to which its effects on the kidneys and bladder appear to be due. It increases the flow of urine, and stimulates the urinary passages; but in too large doses it occasions vomiting and purging. It is in chronic diseases of the kidney and bladder it is most useful. By its astringent effect on the bladder it frequently relieves pain and irritation due to excessive sensibility of the bladder. It has also been used in chronic bronchitis, and in chronic discharges from the bowels and womb, and in bleeding from the womb.

Triticum Repens or **Couch-grass,** a common weed, with a long jointed root-stock, is used to yield a decoction for cases of irritation of the urinary passages. The root-stock is the part employed; 2 to 4 ounces of it are bruised and mixed with 2 pints of water. The mixture is boiled till it is reduced to 1 pint, and then drained. A wine-glassful may be taken frequently. It increases the flow of urine, and soothes the urinary passages, and was supposed to aid the removal of gravel from the bladder.

Alchemilla arvensis (Parsley Breakstone) is employed for the same purposes as the above; of the flower-heads 1 oz. is boiled with 20 of water for ten minutes, and strained. A wine-glassful, thrice daily, is taken.

Chimaphila is a remedy used in America, and known under the name of Pipsissewa, Prince's Pine, and Wintergreen. The plant is the *Chimaphila umbellata*, of the Ericaceæ order, and the leaves are used as powder, of which the dose is 30 to 60 grains, or to yield a fluid extract, of which the dose is 1 teaspoonful.

It contains tannin, and is astringent. It is also a stimulant, the fresh bruised leaves reddening the skin. It resembles bearberry in its effects, and is used popularly in America for kidney diseases, as uva ursi is employed, and for rheumatism, both internally, and externally as a poultice of the leaves to the painful joints. It is said, also, to be useful in scrofulous disease of glands and skin.

Dandelion also acts upon the kidneys (see p. 858).

Remedies which Soothe the Kidneys.

Remedies which soothe the kidneys will be such as will withdraw blood from them, and so lessen the activity of the circulation through them, and also such as will directly act upon the secreting cells of the uriniferous tubules (see p. 290) and diminish their activity. Nothing will more quickly or effectively accomplish the former result than drugs which act briskly upon the skin and bowels, causing free sweating and purging. It has already several times been pointed out that the skin and kidneys work together, the increased activity of one being accompanied by diminished activity of the other. If the skin, therefore, be kept warm and sweating, for example by a dry external heat, the activity of the kidney will be lessened and the quantity of the urine diminished. Such a result is quickly obtained by a Turkish bath. Similarly a mustard foot-bath, or a large mustard poultice to the loins, by drawing the blood to the surface, will relieve the kidneys. These are always the appropriate measures to be taken in acute disease of the kidneys. Then if the skin is kept warm, acetate of ammonia and spirit of nitrous ether will encourage sweating; and in very urgent cases pilocarpine (p. 887) will induce copious perspiration, unburdening the kidneys. Simultaneously with such remedies, the administration of drugs which promote the removal of water by the bowels, such as the compound powder of jalap (p. 861), compound colocynth pill (p. 860), or blue-pill, followed by double-strong seidlitz powder, will greatly aid in relieving the kidneys and reducing inflammatory disturbance.

It is not so easy to say by what means the cells of the kidney may be directly acted upon in order that their secretory activity may be lessened. The author believes that belladonna and its active principle atropine have such an effect (see Section VIII.), and perhaps ergot (p. 835), by contracting the blood-vessels diminishes the supply of blood to the kidneys, and consequently lessens their activity. In acute inflammatory affections, relief to the kidney is, however, to be obtained by the other measures described.

DRUGS WHICH ACT ON THE BLADDER.

Drugs which Stimulate the Bladder.

These drugs have already been stated in preceding paragraphs—copaiba and cubebs (p. 881), pareira brava, buchu, and bearberry (p. 891).

Strychnine (see p. 895) exercises a tonic influence on the muscular walls of the bladder, and may be of value where there is weakness of expulsive power. The bladder may be excited to empty itself by the application of a cold wet sponge close up between the legs. The effect of mental impressions in setting agoing the nervous action that causes emptying of the bladder is well seen by the sound of falling water tending to produce evacuation. An old surgeon, Boerhaave, used to help a patient, unable to pass water, by making an attendant pour water from a height into a basin in a neighbouring room, so that the sound was heard by the patient, ignorant of the little trick played on him, and started the flow.

Remedies which Allay Irritability of the Bladder.

Heat is a powerful means of soothing the bladder, applied either externally as a hot sitz bath, or as a hot sponge or poultice, or taken internally as a hot bland drink such as barley water or linseed tea. Opium, hyoscyamus, and belladonna (all discussed in Section VIII.) are the chief drugs employed; and they are best given in the form of suppositories. But it must not be forgotten that excessive acidity of the urine or other condition may be the cause of the irritability; and the rectifying of this condition would be necessary to permanent relief.

Remedies that Act on the Generative Organs.

It is not desirable to do more than notice a few of the drugs employed to act upon these organs, specially upon the womb.

Many drugs are employed to excite the womb in order to promote the flow of the monthly discharge when it has been arrested or has failed to appear. Of these the one in common use is **Pennyroyal,** the leaves and tops of *Mentha Pulegium*, or *Hedeoma*, the American pennyroyal. It is used as a hot infusion, ½ oz. to 1 pint of water infused for half an hour, and given in half a wine-glassful doses at repeated intervals. **Savin Tops,** the fresh and dried tops of *Juniperus Sabina*, and **Rue** are sometimes employed for a like purpose, as also are drastic purgatives. These are mentioned only that a warning against their use may be given. They produce effects by the intense irritation of stomach and bowels which they set up, irritation which has often proved fatal.

The American **Black Snake-root** (*Cimicifuga racemosa*, or *Actæa racemosa*) is very often used as a uterine stimulant. It has proved useful also in rheumatism, neuralgia, sick headache, and lumbago, in doses of 15 to 60 drops of the tincture, or 5 drops every hour. A decoction is prepared by boiling 1 oz. in 20 ozs. water, of which 1 oz. is a dose. A liquid extract is prepared of which the dose is 3 to 30 drops. In too large doses it produces sickness, vomiting, and depression. In bronchitis it has been used to aid expulsion of matter from the air-tubes.

Blue Cohosh (*Caulophyllum—Pappoose-root—Squaw-root—Blueberry-root*), of the order Berberidaceæ, is much used in America as a tonic and stimulant to the womb. A decoction is made with 1 oz. root to 20 ozs. water, of which 1 oz. is the dose.

Pulsatilla, the flowering herb of *Anemone Pulsatilla* or *Pasque-flower*, is used in similar circumstances. An infusion of 60 grains of the fresh plant in 3 ozs. of water is given during the day in divided doses, and a tincture is prepared of which 1 to 5 drops are given several times daily.

Of the drugs used to control bleeding from the womb, **Ergot** is the chief (see p. 835).

Sulphate of Beberine, prepared from the dried bark of the greenheart tree, *Nectandra Rodiœi*, called Bebeeru bark and imported from British Guiana, has been found useful in excessive discharge, given in 4-grain doses often repeated. It has also been employed as a substitute for quinine in neuralgia.

SECTION VIII.—DRUGS WHICH ACT UPON THE NERVOUS SYSTEM.

Nerve Tonics and Stimulants:
Their Use in the Treatment of Nervousness and Nervous Debility;
Nux Vomica and Strychnine;
Caffein (coffee);
Phosphorus;
Salts of Iron, Silver, and Zinc.

Drugs which Lessen Sensibility and Relieve Pain and Spasm:
Opium and its Active Principle Morphia;
Belladonna and its Active Principle Atropia;
Hyoscyamus and Stramonium;
Indian Hemp (Hashish—Cannabis Indica); and Calabar Bean;
Hemlock (Conium maculatum); Curare or Woorari; Yellow Jasmine (Gelsemium); and Cocaine.
Antipyrin and Phenacetin—Their Use for Headache and Neuralgia.

Drugs which Procure Sleep:
Opium and its Preparations;
Chloral Hydrate and Croton Chloral;
Bromide of Potassium;
Paraldehyd and Urethane;
Sulphonal; Chloralamid; Chlorobrom.

Drugs which Destroy Consciousness (Anæsthetics):
Chloroform and Ether;
Nitrous Oxide or Laughing Gas;
Bichloride of Methylene;
Bichloride of Ethidene;
Bromide of Ethyl; Tetrachloride of Carbon.

If any one who turns to this section will first of all read Section V. of Part I. (p. 84), he will be able to realize what a complicated problem it is to determine by what means the nervous system may be influenced in various directions. One must remember that the nervous system is the link which binds all the other systems together, it is through it that all the organs of the body are kept working together in harmony and sympathy, it is by means of it that delicate adjustments are effected to maintain the balance of power among the bodily organs. Again, it is by means of the nervous system that the relations between the body and the external world are recognized and maintained. Finally, it is the nervous system that is the seat of those higher powers of judgment, reason, imagination, volition, which distinguish the intelligent self-conscious being, and raise him above the level of the automatic machine. Now, one can hardly ask, "What drugs act upon the nervous system?" in view of such considerations, without realizing what an enormous field a full answer to the question would cover. Take a common illustration. A person suffers from pain, say neuralgia of the face, and we shall suppose there is apparently nothing to account for it, and no appearance of anything to suggest that the person is suffering at all—no swelling, nor redness, no decaying tooth, no inflamed ear. It is a pure nerve pain, a sensory nerve is in a state of irritation or agitation for no known reason. What is desired is some remedy which shall diminish the excitability of that particular nerve, which shall soothe it, quiet it down, and so cause the pain to cease. One may apply cold to the part, or heat to the part, or an electric current to the painful nerve; but suppose all these *local* means fail, and a drug requires to be given. It is evident that it is impossible to give a medicine which will single out that one excitable nerve, and lower its sensibility without acting on any other part of the nervous system. The drug that is taken passes into the blood before it can reach the affected part, and it reaches every other part of the nervous system, every other nerve, every part of the spinal cord and brain, and indeed every other part of the body to the same extent that it reaches the part affected with pain. It may so lower the sensibility of this particular nerve that the pain ceases, but it is plain it must have some effect upon other nerves also and other parts of the nervous system. So commanding may have been the pain, that, when it ceases, the person is aware only of its cessation, and thinks of nothing but of the relief experienced, although many other marked effects may have been produced. The commonest of all remedies, in such circumstances, is opium or morphia. But that

drug also acts upon the skin to cause sweating, upon mucous membranes, causing diminution of their secretion, so that there is dry mouth and throat and constipated bowels. It deranges the digestion. It acts upon the brain, at first stimulating it, so that soon the person enjoys a period of delicious exhilaration, is lively, and talkative, and imaginative, and so on. No better illustration could be found of the fact that it is impossible to limit the action of a drug, and that the exceedingly complex nature of the nervous system makes it still more difficult to define the exact nature of the action of drugs upon it. In the following classification of medicines, then, it must be understood that the drugs are classified according to the chief of the actions they produce, or according to the chief purpose for which they are employed; and it is not to be supposed that they produce the one particular effect and none other. Many of the drugs to be considered might appear under each of the different headings, producing as they do a variety of effects, according to the dose given.

Nerve Tonics and Stimulants.

The Uses of Nerve Tonics in Nervousness and Nervous Debility.—Nerve tonics and stimulants are drugs which improve the nutrition of the nervous substance, and so exercise a bracing and strengthening effect upon the nervous system. They are employed in the treatment of many nervous diseases, such diseases specially as are included under such general and vague terms as "nervousness" and "nervous depression." When, through overwork, great physical and mental strain, and so on, the general health has become impaired, the nervous system necessarily shares in the ill health. Under these circumstances certain symptoms may arise, referred to the nervous system, which need not imply any organic disease, but indicate only lessening of the usual activity of the nervous system, or some perversion of activity, simply due to the lowered nutrition of the nervous system and its exhaustion. Among such symptoms are headache, sleeplessness, irritability of temper, lessened power of mental work, and many others of a like kind. Then the symptoms which popularly are associated with "nervousness," such as unusual timidity, readiness in being startled, tendency to emotional disturbance, are common in exhausted conditions of the nervous system, for the irritability or excitability of nervous substance always rapidly becomes increased by exhaustion. Similar symptoms may arise suddenly as the result of a shock, whether physical or mental, implying perverted action of the nervous system. It is in such conditions that tonic treatment is necessary. Now, such tonic treatment will be, in the first place, general. That is, attention will require to be directed to improving the general health by appropriate food, by securing regularity of habits and regularity of the bowels, by change of air and scene, by cheerful occupation and surroundings, and by ordinary tonic remedies. All the usual remedies for improving the nutrition of the body are applicable in such cases: cod-liver oil (p. 877), iron (p. 817), arsenic (p. 822), phosphorus (p. 826), and zinc (p. 870), are those in common use; more rarely silver salts (p. 870) and copper (p. 869) have been employed. It is seldom one or other of these drugs is given alone, usually they are combined; such as, iron and arsenic, zinc and phosphorus, and almost invariably nux vomica or its active principle strychnine is added to the combination (see below). It may be added that, in the author's opinion, there are many such cases in which no remedy acts so quickly or satisfactorily as the constant galvanic current applied to the head and spine. It seems to him to be specially useful in such cases as have arisen from sudden shock, or where prolonged depressed nutrition has induced perverted action.

If we note the use of the iodide of potassium (see p. 825) in nervous diseases, we shall have grouped together the chief drugs employed to affect the nutrition of the nervous system. It is specially used for dispersing overgrowths of connective tissue which, by their pressure on the essential nerve elements, may be the cause of the nervous symptoms.

Nux Vomica and Strychnine.—The *Strychnos nux vomica*, or Koochla tree, is a tree belonging to the natural order Loganiaceæ, common in many parts of Hindostan, also found in Northern Australia, and imported from the East Indies. Its fruit is a globular, smooth, orange-coloured berry, about two inches in diameter, which contains about five seeds. It is the seeds that are used in medicine. A common name for them is *Poison-nut* or *Quaker-buttons.* Nux vomica is bitter; and all parts of the plant are so, probably also poisonous. The bark has been used to adulterate Angostura bark (see p. 840). The seeds are disc-shaped, about an inch in diameter, convex on one side or nearly flat, concave on the other, grayish in colour and

silky. The chief constituents are two alkaloids, **strychnine** and **brucine**, the former of which is present to the extent of $\frac{1}{4}$ to $\frac{1}{2}$ per cent, and the latter $\frac{1}{10}$th to $\frac{1}{2}$ per cent. The **bean of St. Ignatius** is the seed of *Strychnos Ignatii*, found in the Philippine Islands. It also contains strychnine and brucine.

The preparations of nux vomica are as follows:—

	Dose.
Powdered Nux Vomica,............	2 to 5 grains.
Extract of Nux Vomica, ...	$\frac{1}{4}$ to 1 ,,
Tincture of Nux Vomica, ...	5 to 20 drops.
Strychnine, ...	$\frac{1}{30}$ to $\frac{1}{12}$ grain.
Liquor Strychniæ,..................	4 to 8 drops.
Citrate of Iron and Strychnine,	1 to 3 grains.
Citrate of Iron, Quinine, and Strychnine, ...	1 to 3 ,,
Easton's Syrup—Syrup of Iron, Quinine, and Strychnine,.......	$\frac{1}{2}$ to 1 tea-spoonful.

(Each tea-spoonful contains 1 grain phosphate of iron, 1 grain phosphate of quinine, and $\frac{1}{32}$ grain of strychnine.)

Actions and Uses.—Nux vomica and strychnine have an intensely and persistently bitter taste, and are useful as simple vegetable bitters. They are often added to stomachic tonics, such as are described on p. 841, both acid and alkaline, the tincture of nux vomica being added to the alkaline, and the liquor strychniæ to the acid tonics. The special effect of the drug is to increase markedly the excitability of the spinal cord, so that the slightest impression upon the body, communicated by eye, ear, or skin, causes by reflex action marked muscular movements. Thus a person under the influence of the drug will start violently at the slightest sound, or touch; if he sees a carriage coming towards him, as he crosses a street, his muscles may suddenly stiffen up so that he comes to a dead stop and cannot move for an instant. If excessive doses are given, the slightest impression upon any of the senses causes violent muscular spasms over the whole body, convulsions indeed; the teeth and hands are clenched, and such violent spasm of the respiratory muscles that the breathing is arrested. Death takes place by exhaustion and suffocation. These results are not sought for, of course, in medicine. It is a gentle stimulation that is desired, which makes itself evident in increased strength, greater activity, more mental power and spirit, increased sensibility of touch, sight, taste, hearing, and sense in general. The drug acts also on the bowel, increasing the peristaltic movement. Because of these various effects the drug is used as a tonic in weak digestion, and in dyspepsia as the result of excess in alcohol, the tincture of nux vomica or liquor strychniæ being the form for administration. It is also combined with purgatives to exert a tonic influence on the bowel, the extract of nux vomica being suitable, $\frac{1}{2}$ to 1 grain, with, for example, $\frac{1}{8}$ grain podophyllin and $\frac{1}{4}$ grain aloin. In many forms of nervous affection it is useful; in nervous depression in pill, 1 grain of extract with $\frac{1}{8}$ grain phosphide of zinc, or $\frac{1}{32}$ grain of phosphorus. It may be given with iron and arsenic, as 3 grains of Blaud's pill, $\frac{1}{60}$ grain of arsenious acid and $\frac{1}{2}$ grain extract of nux vomica. It is used in cases of paralysis, and in such cases small doses must be begun with, as the patient is usually easily affected by it. Specially does benefit arise from its use in paralysis following diphtheria. It tends to accumulate in the system; but persons quickly get used to the drug, so that one should begin with a small dose, which may then be gradually increased till full doses are being taken. This is always advisable, as many persons are unusually susceptible to its influence. It is employed for sexual impotence. Poisoning by strychnine is met by chloral hydrate and morphia, and strychnine is itself used as an antidote to poisoning by these latter drugs.

Caffein, the active principle of tea and coffee (p. 654), is used in medicine in doses of 1 to 5 grains. There is a citrate of caffein of which the dose is also 1 to 5 grains, and an *effervescing* citrate of caffein is prepared of which the dose is a tea-spoonful. The action of caffein, taken as such, or as coffee, is at first to stimulate the brain and spinal cord, as well as the pulse and breathing. Large doses have a poisonous effect, depressing the heart and breathing, making the pulse irregular; and it may also act as an irritant to stomach and bowels. In the lower animals it produces convulsions like those due to strychnia, and causes death. It is used in medicine as a nerve stimulant in cases of fatigue, and specially for megrim or nervous headache, for which it is very useful, but not so certain in its results as antipyrin (p. 821). Its stimulating action on digestion is marked with some people; in others it rather arrests digestion. It has also an effect upon the kidneys, exciting increased flow of urine.

Drugs which Lessen Sensibility and Relieve Pain and Spasm.

The drugs to be noted under this head are those which diminish the sensitiveness of the nerves of sense, so that they receive impressions less readily. They are dulled or blunted so to

speak. Some of them, such as conium, cocaine, veratrine, aconitia, when directly applied to the skin over a painful part, will so lower the sensibility of the nerves of that part of the skin that it no longer perceives sensations of touch, or heat, or even pain. This effect is called local **anæsthesia** (Greek *an*, without, and *aisthēsis*, sensibility), and the substance an anæsthetic. Prolonged cold will produce such an effect; we all know how numb a part long exposed to the cold becomes, and how extreme cold blunts all the perceptions. Any substance will produce extreme cold which, when placed on the skin freely exposed to the air, rapidly evaporates, and will, therefore, act as a local anæsthetic. Many lotions applied to the skin to relieve pain are composed of such substances—chloroform, ether, &c. A spray of ether directed on a part of the skin will by its rapid evaporation cool the surface down to the freezing point, and then a deep incision may be made in the part without causing any pain. This local anæsthesia is to be distinguished from the general anæsthesia, involving loss of consciousness, produced by the inhalation of chloroform, and other drugs (see p. 906). Drugs which thus diminish the sensibility of nerves have also a quieting influence on the brain, sometimes as part of their direct action, but often merely by the soothing of pain and irritation. It is a common experience that pain will, for long periods, prevent sleep, and as soon as the pain is relieved deep sleep comes on. Substances which relieve pain are called **anodynes** (Greek *a*, without, and *odunē*, pain). Such remedies not only relieve local pain, but exert a general soothing effect upon the body, lessening the activity of various organs, and quieting disordered movement. These are, therefore, called **sedatives** (Latin *sedo*, I ease or assuage), and, because of relieving spasm, **antispasmodics**. The chief of all such drugs is opium.

Opium and Morphia.—The poppy, *Papaver somniferum*, an annual herb, growing wild in Western Asia and South-eastern Europe, is the plant from which opium is obtained, for which purpose it is extensively cultivated in Asia Minor. It has a stem 3 to 5 feet high. The fruit is in the form of the well-known **poppy heads** or **poppy capsules**, which contain the seeds. In the unripe state the wall of the capsule contains branching vessels filled with a milky juice. A few days after the petals have fallen from the flower, horizontal or vertical incisions are made into the poppy capsules with a sharp instrument, not deep enough to cut through the wall of the capsule. The milky juice exudes in tears. Next day the tears, which have changed in colour from white to brown, are scraped off, transferred to a poppy leaf, and formed into cubes. There are several varieties of opium—Turkish, Egyptian, Indian, China, Persian, &c. Turkey opium is considered the finest, and is met with in round or flattened masses from ¼ to 2 lbs. in weight, covered with the poppy leaf, and surrounded with the capsules of a species of rumex (dock). It has a heavy narcotic odour, and a bitter disagreeable taste.

Opium is a very complex substance. It contains the well-known alkaloids, **morphia** and **codeia**, and no less than some seventeen others, of which thebaia, papaverine, and narcotine only need be mentioned. In good Turkey opium morphia exists to the extent of 12 to 15 per cent, and codeia only to the extent of ·2 to ·4 per cent. Morphia was discovered by Sertürner, an apothecary at Eimbeck, in North Germany, in 1816. Besides these alkaloids opium contains a substance, used separately in medicine, called **meconic acid**, and also resin, gum, odorous bodies, saline substances, &c. The preparations of opium and morphia, codeia, &c., are as follows:—

Preparations of Poppy-heads—	DOSE.
Decoction of Poppy (1 oz. bruised capsules, without seeds, boiled for 10 minutes in 15 ozs. water and strained). For external use.	
Syrup of Poppy,	10 to 60 drops.
Opium Preparations—	
Powdered Opium,	½ to 1 grain.
Laudanum (Tincture of Opium),	5 to 30 drops.
Battley's Solution of Opium (Liquor Sedativus),	5 to 20 ,,
Black Drop. (1 drop is equal to 4 drops of laudanum.)	
Nepenthe. (Same as Laudanum.)	
Scotch Paregoric (Ammoniated Tincture of Opium),	30 to 60 ,,
English Paregoric, Paregoric Elixir (Camphorated Tincture of Opium),	15 to 30 ,,
Wine of Opium (1 of opium in 10 of sherry),	10 to 40 ,,
Opium Lozenge ($\frac{1}{10}$ grain extract in each),	1 to 2 lozenges.
Extract of Opium,	¼ to ½ grain.

Opium Preparations (*Continued*):	DOSE.
Compound Opium Powder (opium, black pepper, ginger, caraway, tragacanth),	2 to 5 grains.
Confection of Opium (compound powder in syrup),	5 to 20 ,,
Pill of Lead and Opium (opium 1, acetate of lead 6, confection of roses 1),	4 to 8 ,,
Compound Soap Pill (opium 1, hard soap 4),	3 to 5 ,,
Dover's Powder (Compound Ipecacuanha Powder—opium 1, ipecacuanha 1, sulphate of potash 8),	5 to 10 ,,
Compound Kino Powder (opium 1, kino 15, cinnamon 4),	5 to 20 ,,
Aromatic Powder of Chalk with Opium (aromatic chalk powder 39, opium 1),	10 to 40 ,,
Opium and Starch Enema (see p. 874).	
Opodeldoc (tincture of opium and soap liniment, equal parts).	For external use.
Gall and Opium Ointment (p. 867).	

Morphia Preparations—

Hydrochlorate, Acetate, or Sulphate of Morphia,	$\frac{1}{8}$ to $\frac{1}{2}$ grain.
Solution of Morphia (liquor hydrochlorate of morphia, 50 drops contain $\frac{1}{2}$ grain morphia),	5 to 30 drops.
Morphia Lozenge (each contains $\frac{1}{36}$ grain morphia),	1 or 2 occasionally for cough.
Morphia and Ipecacuanha Lozenge (each contains $\frac{1}{36}$ grain morphia and $\frac{1}{12}$ grain ipecacuanha),	1 or 2.
Morphia Suppository (each contains $\frac{1}{2}$ grain morphia).	
Morphia Suppository with Soap (each contains $\frac{1}{2}$ grain morphia).	
Solution of Morphia for Hypodermic Injection (made of acetate of morphia 1 grain in 12 drops, 1 to 6 drops injected).	
Solution of Bimeconate of Morphia (same strength as laudanum),	5 to 30 drops.

Preparations of Codeia—

Codeia,	$\frac{1}{2}$ grain.
Syrup of Codeia,	1 to 2 tea-spoonfuls.

Actions and Uses of Opium.—Externally opium is used as liniment, plaster, &c., for the relief of pain, but it is doubtful whether the opium in the liniment can relieve pain acting on the unbroken skin; and it is probable that the relief is due to the warm application or to the other ingredients of the liniment. On the other hand, when the skin is broken, opium preparations are absorbed, and then relieve pain; and sometimes a blister is applied to remove the skin, and then morphia is dusted on the raw surface. When taken internally opium, morphia, &c., cause great dryness of the mouth and throat and much thirst, and quickly exert a soothing influence on the stomach and bowels. Secretion is arrested, and the movement of the bowel diminished. The result is a binding effect on the bowels, and most marked relief in inflammatory or colicky affections of the bowels. Free perspiration is caused by opium, but with this exception the activity of secreting organs is diminished. As regards its effect on the nervous system, the first effect on the brain is that of stimulation, manifesting itself in rapidity of thought, brilliance of ideas, talkativeness, exalted imagination accompanied by a feeling of exaltation, and a sense of great comfort and happiness. Or the person is inclined to lie motionless and undisturbed, while a ceaseless procession of ideas and images, of all kinds congruous and ludicrous, is passing through his mind. Following the excitement, if the dose be large enough, drowsiness comes on, and deep sleep supervenes. In very large doses it may be almost impossible to wake the person; and in poisonous doses a condition of stupor arises, the breathing becomes slow and the pulse feeble, the face is pale and with a bluish tinge, the skin clammy, the pupils of the eye are contracted to a fine point, and death occurs from stoppage of breathing.

Many people find no inconvenience from ordinary medicinal doses of opium, save that of the subsequent constipation, and dry furred tongue and much thirst. In others it produces a feeling of nausea, perhaps vomiting is induced, and great depression and headache follow after a few hours. In a few the dose of opium that would produce sleep in the ordinary individual causes restlessness and excitement and sleeplessness lasting several hours. It is quite common for even a small dose, along with considerable sweating, to produce itching of the skin all over the body, so that the person cannot rest from a desire to scratch here, there, and everywhere. Opium is one of the drugs for which tolerance is quickly established, and if it be taken regularly for any time, constantly increased doses are required to maintain the effect. The person who has developed the habit of taking opium in any of its forms suffers from intense depression and wretchedness if the usual

dose is not obtained, but becomes lively and bright after the dose. The constant use gradually exerts a most degrading influence upon the nervous system, the whole moral nature becomes perverted, and a marked tendency to meanness and lying appears. Such a habit can only be broken off by the exercise of much care and patience, by the use of doses continually being diminished by imperceptibly small amounts, and by nourishing and stimulating foods.

Women are more susceptible to the action of opium than men, and *children are peculiarly susceptible, so that opium, laudanum, or any other form should never be administered to a child by an unskilled person. One case is recorded where* 1 *drop of laudanum proved fatal to a child.*

Opium and its preparations are given for the relief of pain, specially pain about stomach or bowels; in pleurisy (p. 266) and in peritonitis (p. 190) they are the chief remedies. Given in the early stage of catarrh (p. 154), or a cold in the head, in the form of Dover's powder, opium often acts like magic; and it is sometimes a proper remedy for cough (p. 284). It is used to procure sleep, but other drugs are more suitable. In painful diarrhœa it is appropriately used. It is the chief drug used in diabetes. Its quieting effects on the circulation make it sometimes useful for internal bleeding, for which purpose it is combined with acetate of lead as the lead and opium pill. Its two principal uses are, however, to relieve pain and spasm; and whenever given for one or other of these purposes it is best given as a subcutaneous injection of morphia, which acts quickly.

Morphia has less tendency to cause sickness, vomiting, sweating, and constipation than opium itself.

Codeia, chiefly used for diabetes, is much less narcotic, and is of little use for the relief of pain.

The treatment of Opium-poisoning consists of the following measures:—Empty the stomach by a dose of 20 grains of sulphate of zinc, and if that fail to act, by means of the stomach-pump. Give draughts of strong coffee, and 4 drops of the solution of atropine (see below), preferably by subcutaneous injection, every 20 minutes (every 10 minutes if it is given by subcutaneous injection) till signs of recovery appear, or till the pupils dilate. Keep the person moving about, do everything to prevent the drowsiness overcoming him by giving him no rest, and rousing him by pulling the ears, nose, hair, &c.

Apomorphia, derived from morphia, is a powerful emetic (see p. 853), but has none of the chief properties of morphia.

Belladonna and Atropia.—Belladonna, or *Atropa Belladonna*, Deadly Nightshade, Dwale, is a herbaceous perennial plant, belonging to the same natural order as the potato—Solanaceæ—and is cultivated in England. It grows 4–6 feet high, has dark-purple bell-shaped leaves (see Plate X.), and produces purplish-black berries of the size of a cherry. The leaves are employed for making the extract and tincture, and the root is used for the liniment, and to yield the active principle, **atropia**, though it is also contained in the leaves. Its chief preparations are:—

Preparations of Belladonna—	DOSE.
Extract of Belladonna,	$\frac{1}{6}$ to 1 grain.
Tincture of Belladonna,	5 to 20 drops.
Juice of Belladonna,	3 to 10 „
Liniment of Belladonna,	For external use.
(Made from the root with spirit and camphor added.)	
Belladonna Ointment.	
Belladonna Plaster.	

Preparations of Atropia—	
Atropia,	$\frac{1}{150}$ to $\frac{1}{80}$ grain.
Liquor Atropia,	For dropping into the eye.
Solution Sulphate of Atropia	1 to 2 drops by the mouth.
Atropia Ointment.	

Actions and Uses.—When taken internally belladonna or its active principle causes great dryness of the mouth, and consequent difficulty of swallowing and thirst. This is due to paralysis of the glands of the mouth, so that no saliva is produced. In the same way the drug paralyses the sweat glands, and causes dryness of the skin, and the mammary gland, arresting the production of milk. It causes marked dilatation of the pupil, and it abolishes the power of accommodating the eyes for objects at different distances, so that the vision of near objects is blurred and indistinct. A red rash not unlike that of scarlet fever comes out on the skin with continued use of the drug. Relaxation of the bowels is produced. It flushes the face, and this flushing with the wide black pupil, gives a look of excitement to the countenance. The head feels full and the vessels throbbing. Breathing is quickened at first, and then slowed. Belladonna diminishes the sensibility of the skin, and acts also upon the muscles, in large doses causing unsteadiness of gait. The brain is stimulated by too large doses, which cause delirium, and convulsions may occur. In poisonous doses death would be due to failure of the heart and breathing.

The purposes for which belladonna or atropia is given are thus partly quite evident. It is given to arrest excessive sweating, specially the night-sweats of phthisis. A $\frac{1}{4}$ grain of the extract in pill is useful for this purpose, and it is frequently given by injection under the skin of $\frac{1}{120}$ grain atropia. The liniment used for hands, feet, or other parts, diminishes excessive sweating in these regions. A thick paint made of extract, sufficiently thinned with glycerine, is painted over the breast to arrest the production of milk. In the same way, or as plaster or liniment, it is used to relieve pain. The liquor atropia is dropped into the eye to relieve inflammation and to dilate the pupil; and belladonna is a frequent ingredient of laxative pills. The reason of all these uses is evident from what has been said.

It is a powerful drug to relieve spasm. For this purpose it is given frequently in epilepsy (see p. 123), in whooping-cough (see p. 416), in asthma (p. 273), and may be tried in St. Vitus' dance (p. 125). To relieve pain or spasm in the bowel, or genital or urinary organs, it is frequently given as a suppository, 2 grains of the extract being in each. It is one of the best remedies for bed-wetting in children; this being often not the fault of the child, but being done without its knowledge and the result of some irritation about the bladder or urinary passages. Three to 5 drops of the tincture should be given the child at bed-time. Here it may be noted that children can tolerate the drug much better than grown-up persons, and it is well in giving it to children for any purpose to begin with quite a safe dose—2 to 3 drops, and after a day or two to begin increasing the dose by a drop or two each time till 7 or 8 drops are being given. In whooping-cough this may be given three or four times a day, *the child's eyes always being watched, and an increase of the dose being stopped whenever the pupils become very wide.* Belladonna has been used as a preventive of scarlet fever, but there seems no ground for the notion that it can prevent the infection. The use of belladonna in inflammations of the eye has been referred to on pp. 371, 372. Belladonna and atropine in their action upon the skin and pupil are the reverse of opium and morphia, and they are used as antidotes in poisoning from opium or morphia (see under Opium), and also in poisoning from Calabar bean (p. 902). The latter is used as an antidote in cases of belladonna poisoning, stimulants, coffee, caffein, being also given, and the patient being kept awake if possible.

Henbane—Hyoscyamus—is a plant (*Hyoscyamus niger*) of the same order as belladonna, the leaves of which are used in medicine. It is a biennial plant, cultivated in Britain and America. It grows 2 or 3 feet high, with pale yellow 5-leaved funnel-shaped flowers (see Plate XIII.), and its fruit is a capsule, which contains the seeds, from which an active principle, **hyoscyamine**, can be prepared. Its preparations are:—

Extract of Henbane,.......	Dose, 3 to 6 grains.
Juice of Henbane, ...	,, $\frac{1}{2}$ to 1 tea-spoonful.
Tincture of Henbane or Hyoscyamus,...............	,, 15 to 60 drops.

Action and Use.—The effects of henbane resemble very much those of belladonna and stramonium. It allays spasm, and is used mainly for that purpose, being added to purgative pills to make their action easy. It is also often used to allay irritability of the bladder. It is given in nervous diseases to diminish excitement and spasm, but in large doses causes delirium like belladonna. It is useful also in affections of the lungs and air-passages, attended by much irritable cough, or in spasmodic diseases connected with these organs.

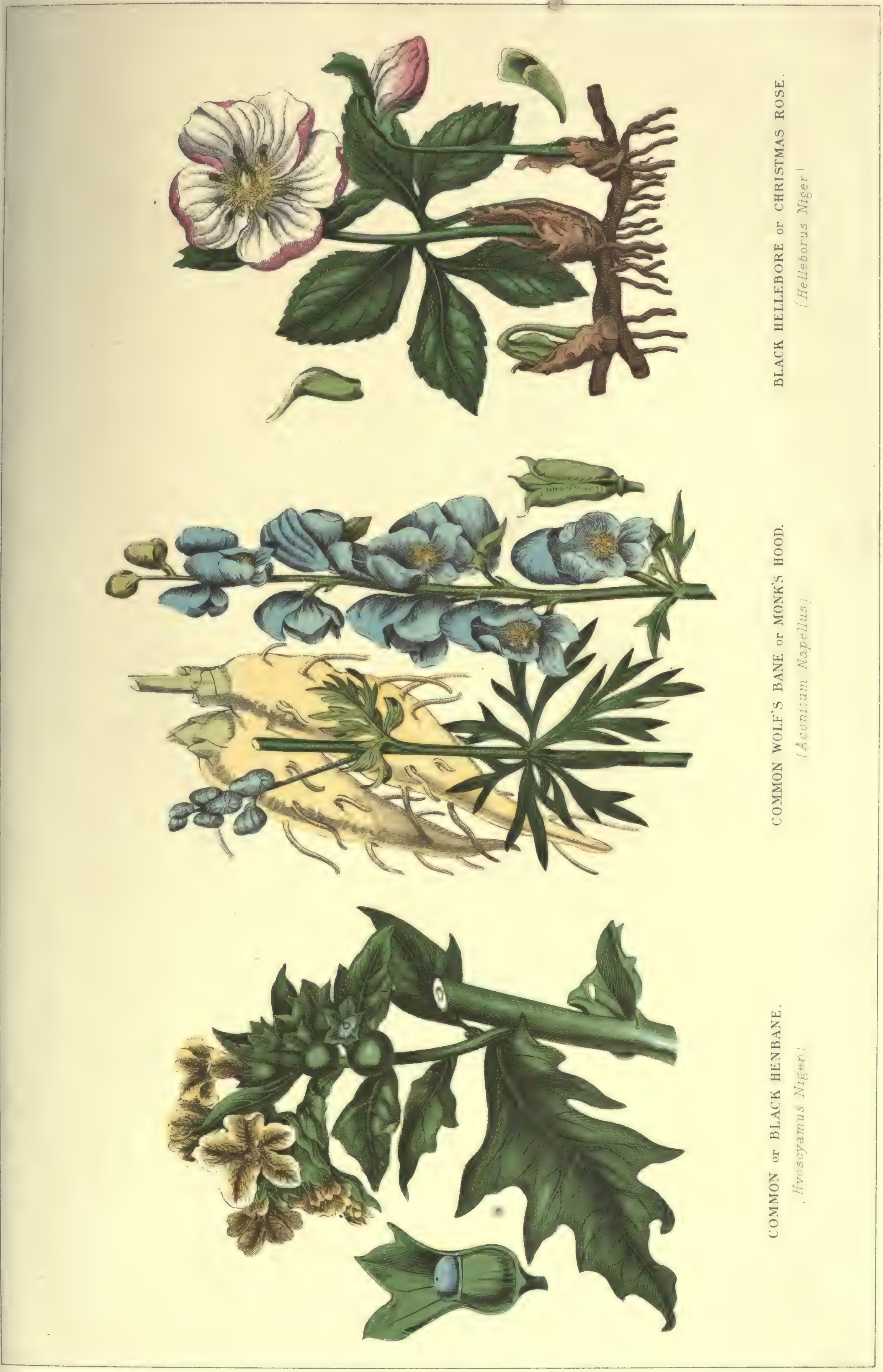
Poisoning by henbane should be met by emetics, warmth to the extremities, cold to the head, and stimulants, particularly coffee.

Stramonium, the leaves and seeds of *Datura Stramonium,* of the Solanaceæ order. It is also called Thorn-apple, and in the United States of America, Jamestown or Jimson weed. It grows as a weed in waste places. It is an annual about 2 feet high. Its leaves, dark green on the upper surface, are pale green below; the flowers are large, white, funnel-shaped, with five points (Plate XII.); the fruit is a capsule beset with spines and contains numerous kidney-shaped seeds. The fresh plant has a heavy narcotic disagreeable odour. A variety which resembles it very closely is *Datura tatula,* but its flowers are purple in colour. All parts of the plant yield a principle which, if not identical with atropine, is a mixture of atropine and hyoscyamine (called **daturine**). The leaves are used in the dry state for smoking; of the seeds the following preparations are made:—

Powdered Leaves,................	Dose, 1 grain.
Extract of Stramonium,........	,, $\frac{1}{4}$ to $\frac{1}{2}$ grain.
Tincture of Stramonium,.......	,, 10 to 20 drops.

Stramonium, belladonna, and henbane cannot be distinguished in their effects from one another when given in corresponding doses, as is to be expected, since their active principles are

Plate XIII.



COMMON or BLACK HENBANE.
(Hyoscyamus Niger.)

COMMON WOLF'S BANE or MONK'S HOOD.
(Aconitum Napellus.)

BLACK HELLEBORE or CHRISTMAS ROSE.
(Helleborus Niger.)

practically identical. Stramonium, like belladonna, produces dryness of the throat, dilatation of the pupils of the eye, delirium, and, in poisonous doses, convulsions and death. It is specially employed to relieve spasm of the respiratory organs, and its main use is for asthma, for which the leaves are smoked like tobacco (p. 273). About 15 grains of dried leaves may be smoked at once, or half that quantity of the fibres of the dried root mixed with sage-leaves or tobacco, in a pipe or cigarette; or tobacco steeped in a strong decoction of stramonium may be used, or cigars similarly treated. Opium is the antidote to poisoning by this drug, and especially morphia given by injection under the skin. In one case 15 grains of hydrochlorate of morphia were required, *given by the mouth*, before the patient was out of danger.

Tobacco.—The tobacco plant (*Nicotiana tabacum*) belongs to the same order as belladonna, henbane, and stramonium. It is indigenous to tropical America. It is an annual plant 4 to 6 feet in height, with a stout heavy stem, with numerous dull-green leaves, those near the root being often 2 feet long and 4 or 5 inches broad. The flowers are rose-coloured, funnel-shaped, with united petals 5-pointed. The fruit is a capsule containing numerous small kidney-shaped seeds. The plant was brought, it is believed, from Virginia. The generic name "Nicotiana," was bestowed on it in honour of Jean Nicot, ambassador of Francis II. in Portugal, "who brought some tobacco from Lisbon and presented it to Catherine de Medicis, as an herb possessing valuable properties; hence also it has been termed **queen's herb**. By some persons the name tobacco is said to have been given to the plant by the Spaniards, who took it from Tobaco, a province of Yucatan, where they first found it and learned its use; others derive it from the island of Tobago; but Humboldt asserts that the word tobacco (tabacco), like the word savannah, maize, cacique, maguey (agave), and manatee, belongs to the ancient language of Hayti, or Saint Domingo; and that it does not properly denote the herb, but the tube through which the smoke is inhaled." The same authority asserts that Europe received the first tobacco-seeds from Yucatan in 1559, and that its cultivation in Europe preceded that of the potato by 120 or 140 years. When Raleigh brought it to England in 1586, it was already largely cultivated in Portugal.

When tobacco is burned it yields about 14 to 18·5 per cent of ash, consisting of salts of potash, lime, and ammonia. It contains besides albumin, gum, resin, extractives, and a powerful principle **nicotine**, and a volatile oil **nicotianin**. Nicotine is a colourless, oily-looking fluid, with an irritating tobacco-like odour and an acrid taste, and was discovered by Posselt and Reimann in 1828. Of this active principle dried tobacco-leaves contain from 2 to 8 and occasionally as high as 11 per cent. This is present in all parts of the plant and is present also in tobacco-smoke. But it would appear that by the burning process much, if not all, of the nicotine disappears and other compounds are formed, whose character varies according as the air has a more or less free access to the burning tobacco. When burned in a pipe a substance called **pyridine** is chiefly formed, but when burned in cigars another substance is formed called **collidine**, which is far less active than pyridine. In the United States an oil of tobacco is prepared by dry distillation of coarsely-powdered tobacco, a wine of tobacco by exhausting 120 grains of tobacco with 4 ounces of sherry, and an ointment made of an aqueous extract of ½ oz. of tobacco and 8 oz. lard; an enema of tobacco is made with 20 grains of tobacco infused in 8 oz. boiling water for half an hour. It used to be employed to produce depression and relaxation in strangulated hernia, and in dislocation, the great muscular depression permitting easy reduction of the dislocation, and also for obstinate constipation and retention of urine; but chloroform has taken its place in the former circumstances, and other substances in the latter. Tobacco acts as an irritant to stomach and bowels, producing copious flow of saliva, sickness, vomiting, colic, and purging. Smoking may produce like effects, the use of snuff, or the application of the leaf to the skin. That is why tobacco is found to relax the bowels, while at the same time, by producing a catarrhal condition, it may give rise to indigestion. The effect of nicotine on the heart is to slow it at first; the beat is then quickened and finally becomes slow and weak, while the face is pale, and a tendency to faint arises. Small doses first slightly excite the nervous system; larger ones cause depression, ending in great muscular tremulousness, convulsions and paralysis; and death is caused by paralysis of the respiratory muscles.

Tobacco used to be employed for itch, but the risk of poisoning was considerable; the smoke was used for asthma and the enema to produce muscular weakness. It is not now employed for such purposes. As to the effects of tobacco-smoking, they are both mildly stimulating and

soothing to the nervous system, and in moderation tobacco-smoking cannot be said to be injurious to many people, though some are so susceptible to its influence that the smallest amount is positively injurious. On the other hand excessive tobacco-smoking is undoubtedly on the increase, and its evil effects are perfectly recognizable and well marked. Apart from furred tongue, dryness and irritability of the throat, there is a bad effect on the stomach and heart. Irritable dyspepsia arises, indigestion with severe heart-burn is common, and palpitation of the heart of a particular kind (smoker's heart). This disappears if smoking is given up for a time. One of the effects of excess in tobacco which is most familiar to the author is dimness of vision, due to an effect upon the nervous structures of the eye, which is called **tobacco amblyopia** or tobacco blindness. In the author's experience it is very common when a smoker consumes between 3 and 4 ounces of tobacco per week. Of course many escape, it is indeed only the comparatively few that go to excess who suffer from loss of sight, yet one never can tell what smoker to excess will escape and who will be caught. The author has not found such tobacco blindness arising if the smoker restricted his supply to 2 oz. per week, though the digestive and heart symptoms may arise from even less. The only remedy for such a state of things is remorselessly and resolutely to cut off the tobacco.

An emetic, followed by stimulants, is the appropriate treatment for poisoning by tobacco.

Indian Hemp, the flowering tops of the female plant of *Cannabis sativa*, grown in the East Indies, which are pressed together in masses and held so by the resin adhering to the fresh tops. One form of it used in India is called by the Arabs **hashish**, by the Indians **bhang** or **siddhi**; the form sent to market is called **gunjah** or **ganga** and **guaza**; while to the resin itself, which may be scraped off the tops, the name **charas** or **churrus** is given. Indian hemp contains a resin called **cannabin** and a volatile oil, **cannaben**.

Its preparations are:—

Extract of Indian Hemp, ...	Dose, $\frac{1}{4}$ to 1 grain.
Tincture of Indian Hemp,.....	,, 5 to 10 drops.

Indian hemp produces a species of intoxication, in which the person's ideas of the natural relations of things become perverted. The patient may, in his disordered imagination, pass through the experience of days and weeks all in a few minutes; his own personality may become of enormously increased importance; faint whispers seem to his ear tones of thunder; and all sorts of fantastic pictures appear to his mind. With different individuals, however, various effects may arise. Some may be made only drowsy and depressed. Sleep and stupor follow the intoxication, pain and spasm being diminished. Coffee and tobacco increase the effects of the drug. In an instance, occurring in the author's experience, the person, who had taken of his own accord $\frac{1}{4}$ grain of extract in pill for headache, felt no particular effects till $1\frac{1}{2}$ hours after, when, having taken dinner, he sat down to enjoy a cigar. The tobacco quickened the influence of the drug, and when seen the person was walking up and down his room without cessation, evidently suffering from acute depression. He complained of a great feeling of anxiety, and intense restlessness which would not permit him to stop his walk for an instant. At the same time his limbs felt like lead, but he walked without difficulty or unsteadiness. Every now and again a wave of depression would pass over him, during which, though spoken to, he would not utter a word. Shortly that would pass off, and then he would talk freely describing his sensations, until another wave of depression would suddenly cause his tongue to cease though his feet kept their restless pacing to and fro. Of course, at no time was he in danger. Someone had advised him to take an emetic of mustard and water, and of that he took two tumblersful, but without effect, the drug having so quieted the stomach. Hot stimulants would have been a more appropriate remedy. Indian hemp is used to relieve pain and to procure sleep, when opium is likely to disagree. It is in cases of painful monthly illness, and in recurring sick headache, that it has been specially used. It has been lauded in the treatment of tetanus—lock-jaw. In India it is often used by being smoked in a pipe.

Calabar Bean, ordeal bean, the seed of the *Physostigma venenosum*, a woody climber somewhat resembling the Spanish bean or scarlet runner, growing near the mouths of the Niger and Old Calabar river in Western Africa. It contains an active principle, called **physostigmin**, or more commonly **eserin**. Its preparations are as follows:—

Powdered Calabar Bean,......	Dose, 1 grain.
Extract of Calabar Bean,.....	,, $\frac{1}{16}$ to $\frac{1}{4}$ grain.
Tincture of Calabar Bean,....	,, 10 drops.
Eserin,............................	,, $\frac{1}{60}$ to $\frac{1}{20}$ grain.

Calabar bean acts chiefly upon the spinal cord, the excitability of which it greatly reduces and in large doses abolishes. The result is a

loss of power over voluntary movements, and diminished sensibility of the skin. Besides these symptoms there are intense prostration, pallor, weak pulse, shortness of breath, and marked contraction of the pupil of the eye. Consciousness is not impaired; sickness, vomiting, diarrhœa, and much perspiration may occur. Poisonous doses cause death by paralysis of breathing. One of the chief uses of the drug is in tetanus (lock-jaw, p. 126), for which it has been shown to be one of the most useful drugs. It is recommended to be given in doses of $\frac{1}{3}$ grain of extract every quarter of an hour till the spasms cease; the action of the drug should be maintained till the tendency to recurrence of the spasm ceases. Another chief use of the drug is in the form of a solution of eserin, dropped into the eye to contract the pupil. For this purpose it is used in glaucoma (see p. 375), though an operation is the chief treatment of this affection. The drug also is antagonistic to belladonna, in poisoning by which it could be used; and, of course, belladonna, or its active principle atropia, would be an appropriate remedy in poisoning from Calabar bean, coffee and other stimulants being also given.

Hemlock, the Poison or Spotted Hemlock, or *Conium maculatum* (Plate XI.), a plant of the natural order Umbelliferæ, which grows wild in Britain. The leaves are gathered when the fruit begins to form, and the full-grown fruit is also gathered and dried for use in medicine. Both leaves and fruit contain an active principle, **conia.** Its preparations are:—

Powdered Hemlock Leaf,	Dose, 2 to 8 grains.
Green Extract of Hemlock,	,, 2 to 6 ,,
Alcoholic Extract of Hemlock,	,, 2 grains.
Fluid Extract of Hemlock (American),	,, 15 drops.
Compound Pill of Hemlock,	,, 5 to 10 grains.
Juice of Hemlock (expressed from the fresh leaves with added spirit),	,, 30 drops to 2 tea-spoonfuls.
Tincture of Hemlock (made *from the fruit*),	,, 20 drops to 1 tea-spoonful.
Vapour of Hemlock (see p. 885).	

The chief action of hemlock is upon the nerve-endings in the voluntary muscles, which they paralyse, so that weakness of the legs and a staggering gait, ending in complete loss of power, are the chief symptoms of large doses. Sensation is not affected, nor the mental functions. The eyelids fall, the pupils dilate, the hands and feet are cold, speech is slow and difficult, and the voice hoarse by relaxation of muscles; and in fatal doses death is caused by paralysis of breathing, and is sometimes accompanied by convulsions. Its chief use is for the relief of cough as vapour, and for St. Vitus' dance.

The treatment of poisoning by conium is an emetic, hot stimulants, and the external application of heat.

The Lesser Hemlock, Fool's Parsley (*Æthusa cynapium*, Plate XI.), was supposed to be a poisonous plant, but recent investigations have shown it not to be in any degree poisonous, the error having arisen from its strong resemblance to conium.

Curare, Woorare, Urari, the South American arrow-poison, is a mixture of various substances, the chief of which is a variety of Strychnos. Its chief effect is to paralyse the nerve-endings in muscle, in large doses the sensory nerves also, and later the spinal marrow. Great relaxation of the muscle is, therefore, produced, the eyelids sharing in the paralysis so that the eyes cannot be opened, and there is complete loss of power over the body, death occurring by paralysis of breathing. The poison is rapidly removed from the body by the kidneys, and if breathing be artifically maintained recovery is likely to occur. The drug has been used chiefly in the treatment of spasmodic diseases, such as lock-jaw, hydrophobia, epilepsy, St. Vitus' dance. In hydrophobia and tetanus it has been given by injection under the skin, $\frac{1}{10}$ grain in watery solution.

Yellow Jasmine, the dried root-stock and rootlets of *Gelsemium sempervirens*, from which the following preparations are made:—

Alcoholic Extract of Gelsemium,	Dose, $\frac{1}{2}$ to 2 grains.
Fluid Extract of Gelsemium (American),	,, 5 to 20 drops.
Tincture of Gelsemium (British Formula),	,, 5 to 20 ,,
Tincture of Gelsemium (American Formula),	,, $\frac{1}{2}$ to 2 tea-spoonfuls.

This is a drug which produces blunting of general sensibility, and in large doses languor, dizziness, impaired sight, drooping eyelids, muscular relaxation, feeble irregular pulse, and death through arrest of breathing. It has been much used in America and for many diseases. That in which undoubted benefit has been obtained from it is neuralgia of the face, specially that

due to cold or rheumatism. It is a drug about which much care needs to be exercised, small doses often producing alarming symptoms. Numerous cases of death from its use have been recorded in America. Morphia, injected under the skin, is said to be the proper remedy, after the stomach has been emptied by an emetic. Stimulants, ammonia, coffee, and whisky should be freely administered, and heat applied to the body.

Cocaine, the acting principle of *Cuca* or *Coca*, described at p. 663. Its preparations are as follows:—

	DOSE.
Coca Wine,	a wine-glassful.
Liquid Extract of Coca,	1 to 4 tea-spoonfuls.
Fluid Extract of Coca (American),	½ to 2 ,,
Extract of the Green Coca Leaves,	5 to 15 grains.
Cocaine,	⅙ to ½ grain.

The effects of coca have been described on p. 663. The wine and liquid extracts are used for their tonic and stimulating effects, in fatigue, and to produce sleep. The active principle, cocaine, when applied to the skin or mucous membrane, destroys sensibility for a time. Applied to the tongue or mouth and throat it completely blunts the sensibility, so that taste cannot be felt. A drop or two of a 4 per cent solution let fall into the eye abolishes sensation, so that simple operations can be performed without pain. Injected into the gum round a tooth it will so lower the sensibility that the tooth can be extracted without pain. It is for such purposes it is chiefly employed. It can produce poisonous effects in too large doses. Large doses cause a feeling of fulness in the head, great restlessness, giddiness, headache, and even delirium; and death results from stoppage of breathing. Stimulants are the appropriate remedy.

Among other remedies for nerve pain are **Antipyrin,** noted on p. 821, and **Phenacetin.** The latter drug is like the former used to reduce temperature in fevers, being given in doses of 8 grains. Both relieve pain, and are valuable in nervous headache and neuralgia.

Drugs which Procure Sleep.

Drugs which procure sleep are called **hypnotics** (Greek *hupnos*, sleep), or soporifics (Latin *sopor*, sleep, and *facio*, I make), terms applied to remedies which calm and soothe the nervous system so that sleep naturally ensues, without being absolutely compelled, as it were. The drugs which act much more strongly and compel sleep, which is then of the nature of a stupor, are called **narcotics,** from Greek *narke*, deep sleep. One and the same drug may be used in both ways, that is to say, a small dose of the drug may be sufficient to procure sleep simply by so relieving pain or restlessness that sleep is not prevented; while it may also be given in a large dose to produce a narcotic effect. Such a drug is opium with its preparations. When a person is under its full influence, vigorous and, in ordinary circumstances, painful impressions may be made upon his body without producing the slightest response. It has been already sufficiently described on p. 897.

Chloral Hydrate is formed by passing chlorine gas through absolute alcohol. It was discovered by Liebig in 1832. It is in the form of colourless crystals of a peculiarly pungent smell and taste.

	DOSE.
Chloral Hydrate,	5 to 20 grains.
Syrup of Chloral Hydrate,	½ to 2 tea-spoonfuls.
(10 grains in each tea-spoonful.)	

Actions and Use.—Chloral hydrate is an irritant to the skin, has a hot burning taste, and applied to a raw surface acts as a powerful irritant. A solution of 5 grains to an ounce of water acts as an antiseptic, preventing decomposition. When it is given internally in doses of 20 grains or thereby it quickly induces sleep, of a natural and refreshing character, the awaking from which is unattended by the headache, sickness, confusion, or feeling of stupidity that usually follows sleep procured by opium. In larger doses the sleep is deeper and more prolonged; the person can with difficulty be awakened from it; pain is abolished; breathing becomes slow and shallow; and the pulse, quickened at first, is afterwards slowed; the pupils are much contracted; and there is complete muscular relaxation. This last effect, with the abolition of pain, is due to the action of the drug upon the spinal marrow. The result of poisonous doses is a great fall in bodily heat and paralysis of the heart. In animals death by chloral poisoning has been prevented by means which maintain the bodily heat, and the treatment of **chloral poisoning** consists in the use of warm blankets, hot bottles, hot stimulants such as hot coffee, hot toddy, &c. The taste for chloral hydrate is apt to grow upon one so that its use cannot readily be given up. When taken habitually, it is apt to produce irritability of the stomach, nervous irritability also, and skin eruptions. With constant use larger doses require to be taken; and persons who are accustomed

to its use are very apt some day, owing to their familiarity with the drug, to take an overdose, a very slight increase of an accustomed dose being sometimes sufficient to cause death. Chloral hydrate is chiefly used to procure sleep, when it is difficult to obtain owing to nervous excitement, as the result of overstrain or worry, in feverish diseases, and in conditions of delirium and insanity, and specially in delirium tremens. It is not nearly so useful for the relief of pain. No drug can compare with opium for such a purpose; and it is useless to use it for neuralgia. It is useful in convulsions, and may be used in cases of convulsions in children, to whom in proper doses it may be given with comparative safety, while opium is for them a most dangerous drug. The dose of chloral for children is 1 grain for each year of the child's age. It is beneficial in sea-sickness. It is the antidote to poisoning by strychnine.

Chloral with Camphor, or Camphorated Chloral, is a mixture of equal parts of chloral hydrate and camphor rubbed together in a mortar. It is a colourless liquid of syrupy consistence. It is used for painting over painful parts in neuralgia and rheumatism.

Croton Chloral Hydrate, or Butyl Chloral Hydrate, is a drug which acts similarly to chloral hydrate. It is made by passing chlorine gas through, not alcohol, but acetic aldehyd. Its dose is from 2 to 15 grains. It is said to act less quickly and surely than chloral hydrate, but to depress the heart less. In particular it lowers the sensibility of nerves of the skin, specially of the sensory nerve of the face. On this account it has been recommended for neuralgia of the face, and tic douloureux along with gelsemium (p. 903); and it has proved useful in cases of nervous headache and painful monthly illness.

Bromal Hydrate is a drug prepared like chloral hydrate, the vapour of bromine being substituted for chlorine. It is very irritating, and cannot be taken internally unless largely diluted, because of burning in the throat, and vomiting and diarrhœa arising owing to irritation of gullet, stomach, and bowels. It is poisonous in smaller doses than chloral, and there is no good reason why it should be used at all.

Bromides of Potassium, Sodium, and Ammonium.—These are salts of bromine with potash, sodium, and ammonium. Bromine is one of the elements, a brownish-red liquid, readily converted into vapour, orange-red in colour, and intensely irritating to throat and eyes. It is obtained from sea-water. The bromides of potash, soda, and ammonia are all used for their soothing effects upon the nervous system. They diminish the excitability of all sensory nerves, acting also upon the spinal cord and brain. The activity of the brain they greatly lessen, and are specially valuable on this account in getting rid of sleeplessness due to restlessness and excitement. In such cases a dose of 10 to 15 grains, taken a short time before going to bed, may be enough to quiet down the brain sufficiently to cause natural sleep. They are particularly useful in delirium tremens, and may for this be combined with chloral hydrate. The bromide of potassium is the most common drug for convulsive diseases, such as epilepsy and child-crowing. It relieves sickness in pregnancy; and the delusions that occasionally trouble pregnant women in the later months are commonly removed by it. With prolonged use of the bromides a condition called **bromism** arises, one of whose symptoms is an eruption of pustules, specially on the face, as well as unsteady gait, impaired memory, and other symptoms of dulled mental power. Bromide of sodium has the same uses as the bromide of potassium, but is less depressing; of the bromide of ammonium the same may be said. It is commonly used with belladonna for whooping-cough. The great advantage of the bromides is safety in their administration. They are most valuable in children's diseases, for which they need never be given in less than 5-grain doses. In convulsions they are the invariable remedy, and they may be given at times when children are apt to be peculiarly restless and irritable, such as the period of teething. At the same time, while they are thus safe, they are never to be given indiscriminately and for the mere sake of saving mother or nurse some little trouble by inducing sleep in the child.

Monobromated Camphor is a compound of camphor and bromine, which produces sleep like the bromides. It has been recommended for that purpose in nervous sleeplessness, in St. Vitus' dance, and in hysteria, and it has been used in epilepsy. Its dose is 2 to 10 grains, and it is given in pill.

Paraldehyd.—Aldehyd is formed by the oxidation of alcohol, a stage before the production of acetic acid, into which pure aldehyd readily passes. Paraldehyd is obtained from aldehyd by treatment with dilute sulphuric or nitric acid. It is at ordinary temperatures a colourless liquid, but becomes crystallized if cooled below 50° Fahrenheit. It has a peculiar ethereal odour. Given in doses varying from 15 to

60 drops, it produces sleep for several hours, leaving behind no headache, digestive disturbance, or other unpleasant symptom. It does not depress the heart. It increases the flow of urine, but has no effect on the skin. It is in sleeplessness, both that due to nervous conditions, and that due to acute disease, and in mania and delirium, particularly delirium from drink, that it is most serviceable. It may be given in 30-drop doses, repeated thrice, at intervals of half an hour, if required. If it fails then to act it need not be continued.

Urethane, or Ethyl Carbamate, is another recent remedy for sleeplessness, which, while producing the tranquil effects of chloral hydrate, has none of its depressing effects upon the heart and respiration. It quiets the brain excited by worry or overwork, and puts it in a condition for natural sleep. Its dose is 4 to 8 grains, repeated every half hour, for 4 or 5 times, till sleep is obtained, or 15 to 30 grains given in one dose; but it is best given in small doses frequently repeated, as vomiting is apt to occur after a large dose. It is said to be an antidote to strychnia poisoning.

Sulphonal is the most recent of all drugs for the production of sleep. It was prepared by Professor E. Baumann, of the University of Freiburg, and described by him in 1888. In doses of from 16 to 60 grains, it produces in from ½ to 2 hours a quiet natural sleep, from which the patient awakens refreshed in from 5 to 8 hours, without any feeling that would suggest that the sleep had been anything but natural. It is free from the disagreeable effects of opium, and the heart-weakening produced by chloral. In simple sleeplessness, in the sleeplessness of fevers, in sleeplessness in lunatics, &c., it may be given with good results and without fear. The author has, from his own experience, formed a high opinion of its value. He finds 15 grains, given at bed-time, to be generally successful in obtaining an uninterrupted sleep for fully 8 hours, with no subsequent bad effects. In his opinion it is far superior to urethane and paraldehyd, from which he failed to get any very satisfactory results in the limited number of cases in which he employed them, while sulphonal yielded immediate benefit.

Chloralamid is another of the newer remedies. It is obtained from chloral hydrate. It occurs in colourless crystals with a faintly bitter taste. Its use is advocated in sleeplessness, in the course of nervous and heart affections, and enteric fever. It is given in 20-grain

doses in a little spirit and water, or in a slightly acid solution.

Chlorobrom is a mixture of chloralamid and bromide of potassium, of each 30 grains in one ounce of water. The dose is one table-spoonful in water. It is recommended in sleeplessness, specially of nervous origin. It is highly praised as a preventive of sea-sickness. A table-spoonful should be taken on going on board ship, and the person should at once go to his berth and lie down. In an hour a second similar dose may be taken, and in another hour a third dose if necessary.

Drugs which Destroy Consciousness: Anæsthetics.

We have already noted in this section several drugs which, locally applied, relieve pain by lessening sensibility, such as cocaine, which are, therefore, rightly enough called **local anæsthetics.** But in the following paragraphs we must consider a number of drugs which produce a diminution of sensibility all over the body, and not merely at one part. Then we have seen that opium, chloral hydrate, Indian hemp, &c., diminish sensibility and relieve pain, and are capable of producing an anæsthetic influence, and abolishing consciousness. They do this, however, as their final effect, the loss of consciousness coming as the crowning effect of a large dose, and such doses as are attended by dangerous weakening of the heart and breathing before the loss of consciousness is obtained. The drugs we are about to consider, on the other hand, suspend consciousness almost to begin with, only later and with continued administration acting injuriously upon the nerve-regulating apparatus of heart and breathing. Where, then, it is a question first and foremost of abolishing consciousness for the removal of pain, or preparatory to the performance of a painful operation, these manifestly are the drugs to be employed. The chief of them are chloroform and ether.

Chloroform is obtained from alcohol by the action of chlorinated lime, the production of chloral being one of the stages in the process. It is a compound of carbon, hydrogen, and chlorine, one combining weight of each of the former to three combining weights of the latter; and it is represented by the formula $CHCl_3$. It is a limpid colourless liquid, of an agreeable ethereal smell, and with a sweet hot taste. It mixes readily with spirit, olive-oil, and turpentine, but requires much water for solution. Its dose and preparations are as follows:—

	DOSE.
Chloroform,	3 to 10 drops.
Chloroform Water (1 of chloroform, 200 of water),	½ to 2 fluid ounces.
Spirit of Chloroform—Chloric Ether,	10 to 60 drops.
Compound Tincture of Chloroform, (Chloroform 2, spirit 8, compound tincture of cardamoms 10.)	10 to 60 ,,
Chloroform Mixture (American), (Chloroform 8, camphor 2, fresh yolk of egg 10, water 80.)	1 to 2 table-spoonfuls.
Liniment of Chloroform (equal parts of chloroform and liniment of camphor).	For external use.

Actions and Uses.—Chloroform has two different effects when applied to the skin, according as the skin is covered over when the chloroform has been put on or left uncovered. In the latter case it quickly evaporates, cools the skin, diminishes sensibility, and reduces pain; in the former case it acts as an irritant, reddens the skin, producing heat and pain and even blistering, but ends by diminishing the sensibility of the part. It is, therefore, used in various circumstances as a liniment for neuralgia, lumbago, and for application to a painful tooth, &c. When taken by the mouth it produces a hot burning sensation in the mouth, gullet, and stomach; and, when it reaches the stomach, acts in the first instance as a stimulant, expelling wind and relieving griping. For this purpose the compound tincture or the mixture of the American Pharmacopeia is the most useful preparation. In large doses it will irritate the stomach and bowels, causing at first pain, vomiting, and purging, but, when absorbed into the blood, it will, by diminishing sensibility, cause the pain to cease; and if the dose has been large enough will cause unconsciousness. Apart from its use as a liniment and for flatulence, it is given directly for its effects upon consciousness; and for that purpose is given as vapour. The person to whom it is to be administered lies upon a bed or couch, all tight articles of clothing, especially about the neck and waist, being removed; the chloroform is dropped upon a folded towel, which is held above the mouth and nostrils, *not touching them*, a space being between the face and the towel, so that air readily passes in to be inhaled. It is not thus pure vapour of chloroform that is inhaled. Very far from that is desired. Indeed, the vapour of the chloroform is, when undiluted, irritating to the air-passages just at first, and could not be respired. When a patient is being put under chloroform, if the towel be held too close to the mouth so that the vapour is too strong, arrest of breathing and spasmodic cough are produced from the irritating effects. The air, therefore, requires to be charged with only a small percentage of chloroform vapour, and this being inhaled gradually blunts the sensibility of the respiratory passages, so that soon a stronger charge can be inhaled, and the towel can be gradually approached. Indeed, throughout the whole procedure of the administration of chloroform, success and freedom from danger depend upon the proportion which the pure atmospheric air and the vapour of chloroform inhaled hold to one another, excess of the chloroform vapour tending to the production of symptoms of poisoning by arrest of breathing or stoppage of the heart, while if the chloroform is properly administered unconsciousness can be maintained for prolonged periods without danger. When chloroform is inhaled thus the first effects are stimulating to the brain. It is the brain that is at the very outset affected. Noises are heard in the ears, feeling and imagination are exalted. Thereafter excitement becomes pronounced, and the patient begins to talk loudly and rapidly or to sing, while gesticulation and often violent struggling ensues, till the chloroform begins to act more powerfully, when the muscles become weakened, the movements are irregular, feeble, and easily controlled, and complete relaxation results. At this period there is complete unconsciousness. Some amount of voluntary power may remain, so that the reflex starting of a limb might occur, if a painful impression were made upon it. But with a little longer inhalation this too ceases, and now any operation can be undertaken without the slightest impression being produced on the patient. The nerve centres which control the breathing and the action of the heart are in full activity. In the previous stage both are highly stimulated, so that the pulse is quick, very quick, and the breathing is also more rapid. But as the chloroform acts the speed diminishes, till, when the appropriate time for operation is reached, the pulse should be strong, full, steady, and at a usual rate of rapidity, and the breathing is regular and deep. Indeed, one accustomed to administer chloroform can gauge by the pulse the proper amount to administer. If the administration be continued beyond the stage now

reached, paralysis of the heart and breathing would arise, the heart beating feebly and irregularly, or suddenly ceasing altogether, and breathing becoming irregular and feeble or arrested. Therefore, as soon as the proper stage has been reached, the inhalation is suspended by removal of the cloth from the neighbourhood of the face, and the patient breathes pure air. As soon as a return to consciousness is indicated by some slight movement, the inhalation is resumed, and so on. Chloroform thus acts upon the highest nerve centres first, abolishing control, then arresting all the mental functions, subsequently destroying sensibility and power of motion, and only, last of all, paralysing the nerve functions which preside over the circulation and breathing. Many people take chloroform with perfect quietness, and without making the least sound or struggle from beginning to end of its administration.

Death by chloroform is most commonly due to stoppage of breathing. It is to be met by all measures which stimulate the breathing—slapping the chest with towels wet with cold water, artificial respiration, &c., care being taken that abundance of pure air is being driven on to the patient from open windows, &c. Breathing may stop because of mechanical obstruction by the falling back of the tongue. This is met by pulling the chin forwards by the fingers hooked under it, and by catching the tongue and pulling it forwards. If the heart stop suddenly, indicated by pallor of lips and face, the patient's head should be quickly lowered, friction and hot sponges used over the heart, and artificial respiration carried on. Sickness is frequent during the administration of chloroform, and is best avoided by the patient having no solid food for several hours before administration; a cup of beef-tea two or three hours before is valuable. After the administration the patient should be kept lying flat and quiet for two hours before any food is given, which may then be cold beef-tea, jellies, &c. After twelve hours, ordinary food, if otherwise suitable, is returned to.

Chloroform must never be given by any unskilled person; and it would be the height of folly for a patient to attempt to administer it to himself.

Chloroform is given not only for the production of unconsciousness to permit of surgical operations, but also for the relief of pain such as accompanies the passage of a calculus or gall stone, for the arrest of convulsions in either adults or children, and in child-bearing. In the latter case it is not necessary to push the administration so far as for surgical operation, unless the employment of instrumental means of delivery is required.

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It is generally supposed that any affection of the heart would be an indication against the administration of chloroform. This is not so. It suggests, of course, the necessity of great care in its administration. But if any heart affection exists, the incomplete administration of chloroform during an operation would be attended by more risk than its complete administration. The necessity exists, in such cases, of guarding the heart from shock, and this is best done by producing complete anæsthesia. Many of the deaths during chloroform inhalation have apparently occurred because enough had not been given, and the impression made by the operation upon sensory nerves had by reflex action caused sudden arrest of the heart.

Ether.—Sulphuric ether is prepared from alcohol by distillation with sulphuric acid. It is a compound of carbon, hydrogen, and oxygen, and has the formula $C_4H_{10}O$. It is a colourless, very volatile liquid; and highly inflammable.

	DOSE.
Ether,	20 to 60 drops.
Spirit of Ether (Hoffmann's Anodyne),	30 to 60 ,,

Ether evaporates with great rapidity, and it is, on that account, applied to the skin as a spray either to relieve pain by its cooling effect, or by freezing the part to permit of incisions being made without causing pain. As with chloroform, if it be applied under cover it reddens and blisters the skin. It is used, like chloroform, specially in the form of spirit of ether, as a stimulant to the stomach to expel wind and relieve spasm. At the same time it stimulates the heart, and is employed in palpitation, faintness, and depression because of its rapid action. In hysterical flatulence it is very useful, and in spasmodic cough and asthma. Ether is employed in exactly the same way as chloroform to abolish consciousness and permit surgical operations. It has advantages over chloroform for this purpose, but disadvantages also attend its use. It has been shown to have a much less paralysing influence on the heart than chloroform, and death from heart failure is a much less likely occurrence under the administration of ether than chloroform. It is, therefore, a safer anæsthetic. But the stimulating effects of ether are more prolonged than those of chloroform. It takes a much longer time to induce complete insensibility; there is much more struggling and violence; and more irritation of the air-passages with the vapour,

so that even a catarrh may be brought on by its use. The inflammability of ether renders it necessary to be on guard against a light being brought near when it is in use. The risks of chloroform and the disadvantages of ether are both largely diminished by putting the patient under chloroform till insensibility is produced, and then substituting ether to maintain the condition.

Nitrous Oxide, or **Laughing Gas,** is a colourless odourless gas, made by heating nitrate of ammonia. It is a compound of nitrogen and oxygen, and its chemical formula is N_2O. In ordinary circumstances it is a gas, but under pressure it is condensed to a liquid, and kept in strong iron bottles, whence it is allowed to escape for use into a gasometer. It must be inhaled pure without any admixture of air. When so inhaled it takes the place of oxygen in the blood, converts the arterial into venous blood, and as a result a condition, so far as the blood is concerned, resembling suffocation arises. The face becomes livid and bloated, and the breathing stertorous, and muscular twitchings begin to occur. These effects will be produced after about 1 minute's inhalation. The person is at this time completely unconscious, and minor operations, such as extraction of a tooth, &c., can be performed without pain. If the inhalation be stopped at this stage, recovery takes place, and in from $\frac{1}{2}$ to 1 minute all the symptoms named will have disappeared and natural breathing be fully restored. If the inhalation were carried beyond this stage, the action of the heart and of breathing would be arrested. After the immediate effects have passed away, the patient usually feels some degree of exhilaration, and his laughter is readily excited. If this gas be inhaled *mixed with air*, or if after the pure gas has been inhaled for a little, and before it has had time to produce unconsciousness it be stopped and air inspired, a high degree of mental excitement is produced; the patient exhibits an uncontrollable desire to laugh, dance, gesticulate; and sometimes the excitement ends with a fit of pugnacity. But this series of phenomena, on account of which the gas was called "laughing gas", only occurs when the gas is not administered pure, without admixture of air.

Bichloride of Methylene is obtained from chloroform by the action of nascent hydrogen. Its formula is CH_2Cl_2, that of chloroform is $CHCl_3$. So that one atom of chlorine (Cl) has been removed from chloroform, and for it has been substituted one atom of hydrogen (H). It is a colourless volatile liquid, resembling chloroform in smell. It acts very much like chloroform, though it is attended with less risk. It has not, however, come to be very widely used in surgical practice.

Bichloride of Ethylene, or **Dichloride of Ethidene,** is another anæsthetic which for its safety has been recommended as a substitute for chloroform. Its formula is $C_2H_4Cl_2$. It is a colourless thin oily liquid, with a smell like chloroform.

Bromide of Ethyl, Hydrobromic Ether, is prepared by the action of bromine upon alcohol in the presence of phosphorus. Its formula is C_2H_5Br. It is a colourless volatile liquid, of strong ethereal odour and sweet taste. It is said to be an agreeable and rapid anæsthetic, its effects passing off more quickly than those of chloroform, and sickness being less common with it. Its advocates have pronounced it safer than chloroform, though death has happened under its administration.

Iodide of Ethyl, Hydriodic Ether, is a similar preparation, iodine being substituted for bromine, and it also acts as a general anæsthetic. Its chief use is for spasmodic attacks, specially for spasmodic asthma. It is put up in small glass capsules, each containing 5 drops, the capsule being encased in cotton wool and silk. When the attack comes on the capsule is crushed between finger and thumb, and the vapour inhaled through the wool.

Tetrachloride of Carbon (CCl_4), a colourless thin oily liquid of aromatic smell. It produces great weakness of the heart, and is not used for general anæsthesia. It has been used as an inhalation to relieve hay-fever and neuralgic pains.

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SECTION IX.—REMEDIES FOR EXTERNAL APPLICATION.

Antiseptics:

Carbolic Acid; Sulphocarbolate of Soda and Zinc; Resorcin;
Boracic Acid and Boroglyceride;
Permanganate of Potash—Condy's Fluid;
Iodoform; Perchloride of Mercury—The Comparative Value of Various Disinfectants;
Eucalyptus Oil; Terebene; Thymol; Menthol; Sanitas;
Chlorine Gas;
Burnett's Disinfecting Fluia.

Remedies which Cause Redness and Blister:

Mustard—Its Uses as Poultice, Footbath, and Emetic;
Turpentine; Ammonia Liniment;
Cantharides (Spanish-fly).

Stimulating Liniments, Washes, and Ointments:

Red Wash; Lotions of Zinc; &c.;
Ointments of Boracic and Carbolic Acids, Creasote, Mercury, Iodine, Iodoform, and Tar; Blue, Red, Yellow, and White Precipitate Ointments, Resinous and Sulphur Ointments, Chrisma Sulphur, and Zinc Ointment.

Applications for Bleeding—Styptic or Astringent Applications:

Borax and Alum, Catechu, and Oak Bark;
Hazeline and Matico.

Soothing Liniments, Washes, and Ointments:

Applications of Opium and Belladonna;
Aconite; Carron Oil;
Veratria; Conium; Gall; Acetate of Lead;
Glycerine.

Antiseptics.

Antiseptics (Greek *anti*, against, and *sepein*, to rot) are substances which arrest putrefaction or decomposition. This they effect by preventing the development of the minute organisms on which such decompositions depend. All this has been fully explained at the beginning of Section XII., Part I., p. 384. They are required for external use to prevent putrefaction occurring in wounds, and they are also employed to cleanse instruments, to wash the hands, &c., in order to prevent the conveyance of infective material from one person to another. It has been pointed out on p. 395, that while certain substances only prevent the development of such organisms, other substances absolutely destroy them, and that this latter process is true disinfection. Disregarding, however, such fine distinctions, we shall note in these paragraphs all the various substances employed for such purposes.

Carbolic Acid, Phenic Acid, Phenol, or Phenylic Alcohol, is an acid obtained from coal-tar by fractional distillation and purification. When pure it is in colourless needle-shaped crystals; and on the addition of 6 per cent of water it becomes and remains liquid. Its varieties as sold are as follows:—

No. 1 Carbolic Acid is pure acid, and is obtained in crystals, or with 6 per cent water as a liquid. One part makes a clear solution with 14 of water, and is best adapted for surgical or medical use.

No. 2 Carbolic Acid may be obtained as crystals or liquid. It makes a clear solution with 20 parts of water, is suited for surgical purposes and for the sick-room. 1 oz. in 2 pints of water may be used for sprinkling about.

No. 4 Carbolic Acid consists of 20 per cent carbolic acid and 80 per cent cresylic acid, and is used for disinfecting purposes, for drains, sinks, &c., for which it may be used of a strength of 1 oz. to 2 pints hot water.

No. 5 Carbolic Acid is a liquid adapted for stables, dust-bins, &c.

The preparations of carbolic acid are as follows:—

Glycerine of Carbolic Acid—Carbolic acid 1 oz., glycerine 4 ozs.

Carbolic Acid Ointment—Carbolic acid 1, soft paraffin 12, hard paraffin 6.

Carbolic Acid Lotion—Carbolic acid 1, water 19, or upwards.

Carbolic Oil—Crystals of carbolic acid 1, olive-oil 9.

Vapour of Carbolic Acid—20 drops of No. 1 liquid acid in a pint of water at 140° F.

Spray of Carbolic Acid—3 drops of No. 1 liquid acid in 1 oz. of water.

Carbolic acid is a true disinfectant as well as an antiseptic. In weak solutions it simply prevents the growth of organisms in stronger solutions it destroys them. One part in 40 of water is the strength usually employed for washing hands, and as a lotion for wounds. When it is applied, full strength, to the skin it produces

a white stain by destroying the immediate surface, and it greatly diminishes the sensibility of the part. It is frequently used of this strength to destroy foul ulcers, and as a paint for the throat in diphtheritic ulceration, and to apply to the skin in ringworm and other diseases dependent upon low forms of life, while the ointment is used to relieve itching diseases of the skin. The strong acid applied to the cavity of a tooth is one of the speediest remedies for toothache. It is best applied by a small fine camel-hair pencil, the hair being cut short. The cavity is brushed out several times with the brush soaked in the acid, the mouth being frequently rinsed with lukewarm water to remove excess of acid without burning the tongue and gums. The acid in weak solutions (1 to 40, or 1 to 30, or 1 to 20) is employed as a stimulating wash. Carbolic acid makes an excellent mouth wash along with tincture of myrrh and borax and glycerine. Take ½ ounce of each, mix, and make up the solution to 5 ounces with water. A small quantity of this, say about a tea-spoonful, in a wine-glassful of lukewarm water makes a most excellent mouth wash. It most effectively removes from the mouth the smell of tobacco smoke, and besides is an excellent preservative of the teeth and gums. In the form of the vapour, carbolic acid is used in bronchitis and other lung diseases attended by foul expectoration, and 1 part mixed with 3 of creasote may be used on Coghill's inhaler, as described on p. 882, in consumption. Common cold, beginning in the nostrils, is said to be much relieved by a douche of a solution containing 3 drops in an ounce of water, applied to the nostrils by means of a small ear-syringe, and to the throat as a gargle. It is even taken internally in cases of stomach disease attended by fermentative changes, being given in from 1 to 3 drops (No. 1 acid) largely diluted, to destroy the organisms causing the fermentation. Taken in large doses, or in strong solution, it produces the signs of irritation of stomach and bowels, vomiting and purging, and after absorption produces collapse, delirium, perhaps convulsions, and death. Giddiness, headache, lassitude, and unconsciousness also attend poisoning by the acid. Poisonous effects may arise owing to absorption from a large wound covered by carbolic acid dressings. The urine acquires a dark and even black colour from such absorption. In cases of poisoning by swallowing the acid, the stomach should be emptied by means of the stomach-pump or by emetics, then olive-oil should be administered, and thereafter 10-grain doses of sulphate of soda to aid its removal from the blood.

Sulphocarbolate of Soda, and **Sulphocarbolate of Zinc,** are formed from sulphuric and carbolic acid, with soda or zinc, as the case may be. The former is given internally in 10 to 15 grain doses to prevent fermentation in the stomach, and the latter is used in solution, 2 grains to 1 ounce of water, as a stimulating and antiseptic dressing for wounds with discharge.

Resorcin is a derivative of carbolic acid. It is used as a dressing for wounds and sores of all kinds in solutions varying in strength from 1 to 50 to 1 to 20 of water. It has been used in diphtheria as a paint to the throat, and an ointment made with ¼ to ⅞ oz. vaseline, applied to the face every 4 hours in erysipelas, is said to shorten the disease. A 1 per cent solution is a useful dressing for wounds. It is given internally, 5 grains with syrup of oranges and well diluted, to prevent fermentation in the stomach. It may be used for this purpose thrice daily before meals. It produces copious perspiration and has been employed to reduce fever of all kinds.

Creasote is a product of the distillation of wood-tar. Its dose and preparations are as follows:—Creasote—dose, 1 to 3 drops. Vapour of creasote (creasote 80 drops, light carbonate of magnesia 30 grains, water to 1 ounce), a tea-spoonful to a pint of water at 140° F. for inhalation. Creasote ointment, 60 drops to 1 ounce simple ointment. Creasote destroys low organisms and is employed for this property. Thus it may be used to stop toothache in a decayed tooth, as carbolic acid is used (see first col.). It is used in chronic bronchitis and in consumption to lessen cough and spit, either as vapour, or dropped on the lint of a Coghill inhaler (see p. 883), or it may be administered internally with cod-liver oil, 1 to 3 drops to each dose of the oil. The ointment may be employed as an antiseptic dressing.

Boracic Acid, or Boric Acid, is in the form of colourless, odourless plates, with a slightly bitter taste. It also is an antiseptic and is used for wounds and sores as a lotion, 1 oz. in 20 of hot water, or as an ointment. The ointment may be made of boracic acid in fine powder 3 ounces, paraffin melting at 135° 5 ounces, and vaseline 10 ounces, and is an excellent healing application. Boracic acid is largely used for the preservation of milk. The powdered acid, mixed with starch, is a useful dusting powder for infants; and the powder itself sprinkled in

the socks prevents the disagreeable odour of sweating feet.

Boroglyceride is a patented preparation made by heating 92 parts of glycerine with 62 parts of boracic acid. It is used as a preservative of meat, fish, milk, being used in solution for that purpose, 1 in 40 of water. It is also used as a surgical dressing.

Sulphurous Acid, a solution of sulphurous acid gas in water, is a powerful destroyer of decomposing material. This it effects by removing oxygen from the organic substance and thus destroying it. It is the gas which is liberated from burning sulphur, which is employed as a disinfectant. It is applied as a lotion, 1 oz. to 2 or more of water with the addition of a little glycerine, to ringworm, thrush, and as a spray in sore-throat. It is also given in doses varying from a few drops to a tea-spoonful, well diluted, in cases of vomiting dependent upon fermentation in the stomach.

Permanganate of Potash occurs as dark purple crystals, which readily dissolve in water to a pink solution. It is a substance which quickly destroys organic matter by giving off oxygen which unites with the organic substance. **Condy's red fluid** is a solution of the strength of 2 grains to the ounce of water. It is a powerful disinfectant, and will remove the smell from foul sores and destroy any foul smell on the hands. A few grains only need to be dissolved in the water and the hands well washed with it. It has been recommended for internal administration in cases of absence of the monthly discharge, being given in pill, 2 or 3 grains in each, three or four times daily for some days before the illness is due.

Permanganate of Soda in solution is also used as a disinfectant, and is a green solution.

Iodoform, a compound of carbon hydrogen and iodine, is a powder in shining lemon-yellow crystalline scales, with a very powerful and disagreeable odour. It is a strong antiseptic, but its own persistent and easily perceived odour renders it less desirable for use. The smell is covered by equal parts of it and Tonquin bean or by ground coffee. It diminishes the sensibility of the part to which it is applied. It is very useful as an application to foul sores, or to sores or wounds about the anus. It may be dusted on as a powder, or applied as an ointment, 1 in 4 or less of vaseline. As a snuff it is useful in common cold in the head. Made into suppositories, 5 grains in each, it is a most useful application to irritable and indeed all kinds of piles. It is occasionally administered internally, ½ to 3 grains in pill; and has been so employed with success in ulceration of the stomach. It may produce disagreeable effects on the nervous system, sleeplessness, headache, irritability, and loss of memory. These effects are said to be lessened be 10-grain doses of bicarbonate of soda or potash every hour.

Perchloride of Mercury Solution—Solution of Corrosive Sublimate (see p. 824). This is one of the most powerful of known antiseptics. Dr. Koch of Berlin, who has done more than anyone else in the way of systematic study of the causes of putrefaction and decomposition and the circumstances which favour or hinder their growth, has made a series of comparative experiments with the organism that is the cause of splenic fever (see p. 391), and various disinfectants. He found that a solution of

1 part of Carbolic Acid in	1,250	parts of water hindered the growth of the organism.
1 part of Boracic Acid in	1,250	,, ,, ,, ,,
1 part of Chlorine in	1,500	,, ,, ,, ,,
1 part of Eucalyptol in	2,500	,, ,, ,, ,,
1 part of Camphor in	2,500	,, ,, ,, ,,
1 part of Permanganate of Potash in	3,000	,, ,, ,, ,,
1 part of Oil of Cloves in	5,000	,, ,, ,, ,,
1 part of Peppermint Oil in	33,000	,, ,, ,, ,,
1 part of Thymol in	80,000	,, ,, ,, ,,
1 part of **Corrosive Sublimate** in	**1,000,000**	,, ,, ,, ,,

The enormous superiority of this antiseptic agent over every other in its destructive power is, therefore, apparent. One grain dissolved in one million grains of water still exerts its antiseptic power; and if the strength is increased threefold and made 1 grain in 300,000 the growth of the organism is not only hindered but totally prevented! One grain dissolved in 40 pounds weight of water is 1 in 300,000, that is in round numbers 1 grain in 4 gallons of water. It is, therefore, very extensively used as a disinfecting lotion to wounds, as a disinfecting uterine injection after child-birth, and to impregnate gauze, lint, cotton wool, prepared as dressing for wounds. The strength of solution employed for disinfection purposes varies from 1 in 1500 to 1 in 10,000. One grain dissolved in 10 ounces (½ pint) of water makes a solution a very little stronger than 1 in 5000. This can be used for disinfecting hands, for uterine in-

jection after child-birth, care being taken that it runs freely from the passage and is not retained. The author is accustomed to order such a solution in cases of scarlet fever for sponging the patient's body. The whole body is sponged daily, beginning a few days before the skin begins to peel, say on the sixth or seventh day of the fever, throughout the whole illness till all the peeling skin has been removed, that is to the end of the sixth week. After the sponging the body is lightly anointed with carbolic or other oil. In this way disinfection is achieved throughout the illness, and risk of the spread of the disease reduced to as little as it is possible.

Eucalyptus.—The *Eucalyptus globulus* or *Blue Gum-tree*, of the natural order Myrtaceæ, belongs to Tasmania. It was introduced into Europe in 1856, and has since been planted in the southern part of Europe, in Northern Africa, Southern United States, and California. It is a rapid grower, and attains a height of 200 feet. The leaves of old trees have a length of 6 to 12 inches, and have a strong camphoraceous odour; and they yield 6 per cent of a volatile oil, called oil of eucalyptus, or **Eucalyptol**. To eucalyptus the power of curing malaria has been ascribed, and the tree has been freely planted in malarious districts in the belief that it destroys malaria in the locality. It is undoubtedly a powerful antiseptic and disinfectant, and is used for surgical dressings. Internally it has been used in blood-poisoning, and in consumption, bronchitis with foul-smelling expectoration, and in catarrhal conditions of the bladder. It may be administered in doses of from 1 to 5 drops made into an emulsion with gum tragacanth and any flavouring syrup. It is removed from the body by the lungs and kidneys, and may thus exert upon them a special healing influence. A tincture of eucalyptus leaves may be made by steeping one part of the leaves in sufficient proof spirit to produce 5 parts of tincture, of which the dose is 15 drops to 2 tea-spoonfuls. This is a very suitable form of administration, and in lung affections may be added to cod-liver oil, the fishy flavour of which it removes. It may be used for inhalation with Coghill's inhaler (see p. 883); and 10 to 60 drops of a mixture of equal parts of the oil and rectified spirit are used as an inhalation in diphtheria.

Terebene is prepared from oil of turpentine by oxidation with sulphuric acid. It is used for inhalation as eucalyptol, and is also given internally in doses of 5 to 20 drops, chiefly in chronic bronchitis, and other lung affections, as it acts as a stimulant to the mucous membrane. It is sometimes used for flatulent distension of the stomach when the cause is fermentative changes in the food. It is a powerful antiseptic and deodorant.

Thymol is a crystalline substance obtained from the volatile oils of common thyme and other plants. It is a strong antiseptic (see p. 912) and disinfectant. When given internally it is expelled by lungs and kidneys, irritating their lining membrane. It is used in surgery, and is also employed as gargle in sore-throat, and as inhalation in lung affections. It is also employed for skin diseases, and a thymol soap is prepared. When given internally the dose is ½ to 2 grains and upwards, taken in pill with soap or in oily solution.

Thymol Lotion—for antiseptic purposes and disinfectant for sick-room, 1 part thymol in 800 warm water.
Thymol Ointment—5 to 30 grains to 1 oz. vaseline.
Thymol Vapour—6 grains thymol, 1 drachm rectified spirit, 3 grains carbonate of magnesia, water to 1 ounce. A tea-spoonful to 1 pint of water at 140° F. for inhalation in catarrh of air-passages.

Menthol, Peppermint Camphor, a white crystalline substance distilled from the fresh *Mentha arvensis* and *M. piperita*. It is a strong antiseptic. When rubbed on the skin it causes a burning sensation, replaced by a feeling of intense coldness if the part is blown upon. It is usually sold in the form of cones, **neuralgic cones**, for rubbing on any part affected with neuralgia, or the forehead for headache, &c. Liniment of menthol is made with 3 parts of menthol, 4 of chloroform, and olive-oil to 16, and is used for lumbago, neuralgia, and sciatica. Chinese oil of peppermint, called *Po-ho-yo*, Japanese Drops, or *Gouttes Japonnaises*, is sold in small bottles for the relief of neuralgia. It contains much menthol, from which it derives its properties.

Sanitas is a patent preparation, derived from turpentine, which owes its disinfectant properties to ozonic ether or peroxide of hydrogen.

Chlorine Gas is a greenish-yellow gas, with a suffocating odour. It is the active agent in bleaching powders, and is contained in the so-called chloride of lime, which is, properly speaking, chlorinated lime. This chlorinated lime is used for disinfecting properties, as it gives off chlorine slowly when exposed to the air. The vapour is heavier than air, and in order to permeate an apartment ought to be allowed to pass off nearer the roof of an apartment than the floor, for then it will sink and mix with the air of the room. The dish containing the chlorin-

ated lime should, therefore, be placed on a high shelf. Another method of obtaining it is to put a saucer containing salt, binoxide of manganese, and sulphuric acid on a high shelf; chlorine is evolved from the mixture. Another way is to make a strong solution of chlorinated lime, dip cloths into it, and hang them on a line stretched across the apartment near the roof. The cloths, it must not be forgotten, will be destroyed by the strong solution. Solutions of chlorinated lime or of chlorinated soda are employed to disinfect the hands or to disinfect wounds and ulcers.

Burnett's (Sir Wm.) **Disinfecting Fluid** is a solution of chloride of zinc of specific gravity 2.

Remedies which Redden and Blister the Skin.

One method of treating diseases continually employed in medicine is that by **counter-irritation.** This implies that when one part of the body is in a disturbed state, subject to pain, to threatened inflammation, &c., a neighbouring part is so acted on as to markedly irritate it and cause a rush of blood to it. That is to say, a temporary inflammation is aroused in the neighbouring part, and the disordered portion is in consequence relieved. The blood which is drawn to the place that is the seat of the counter-irritation is to some extent withdrawn from the threatened district. Thus when a mustard poultice is applied to the chest, so that the skin is reddened, the deep parts are relieved to the extent to which the blood attracted to the surface has come from the deep parts. Not only is the threatened part relieved by a diminished blood-supply, but it is believed that the irritation by nervous action will modify its activity and assist in the relief. There are various degrees of counter-irritation. By one set of remedies only a temporary redness of the skin is produced. These are called **rubefacients** (Latin *rubrum*, red, and *facio*, I make), and include hot water and hot applications, mustard, ammonia, camphor, vapour of chloroform, ether, turpentine, and various aromatic substances. The next degree of counter-irritation is that produced by a blister, a **vesicant** (Latin *vesica*, a blister); they are also called **epispastics** (Greek *epi*, upon, and *spao*, I draw). The chief of these is Spanish-fly or cantharides. Ammonia when long applied and confined acts thus, and iodine also. A third degree of counter-irritation is effected, when the remedy produces a crop of pustules, such as is produced by croton-oil. By the second and third degrees not only is a more profound effect produced at the time, but it lasts much longer, and its beneficial effect is thus maintained without further trouble.

Mustard.—There are two varieties of mustard —white and black, the former derived from *Brassica* (or *Sinapis*) *alba*, and the latter from *Brassica nigra* (p. 593).

A mustard poultice is prepared by mixing 2½ ounces of mustard with 2 or 3 ounces lukewarm water. Mix a similar quantity of linseed meal with half a pint of boiling water, then add the mustard mixture, stirring constantly. Where a less active poultice is desired, double the quantity of linseed meal may be taken.

Mustard paper is cartridge paper spread with mustard mixed with a solution of gutta percha. It should be immersed for a few seconds in tepid water before being applied, and should be well pressed down on to the skin. The Rigollot's mustard leaves are the form chiefly used. They act with great rapidity, reddening the skin with intense burning pain in 2 or 3 minutes. They need not be left on longer than 10 to 15 minutes, and even 5 minutes may be enough if they cannot be longer borne. In cases of persons with very delicate skin a layer or two of damped muslin may be placed between the leaf and the skin to make the action less violent.

A mustard foot-bath may be used as a general stimulant, for example, at the commencement of a common cold. In such a case the water should be as hot as can be borne, and two table-spoonfuls of mustard or thereby may be used. It may be used as a derivative, to draw blood from the head in head affections or from the lungs in chest affections. For this purpose the water should be only lukewarm.

A general mustard bath is sometimes employed. For children a table-spoonful of mustard should be added to the bath sufficiently large for the child, and the child held in it by the nurse's arms till they tingle. It is used in bronchitis, and in the fevers with rash where the eruption has not been well developed or has faded too soon. The water should be only lukewarm. For adults a general mustard bath would require from 2 to 3 ounces and upwards of mustard.

Mustard-oil is the oil distilled from the seeds of mustard after they have been steeped with water. It is used as a stimulating liniment and for similar purposes to mustard itself.

Compound Liniment of Mustard is made of oil of mustard 1 drachm, ethereal extract of mezereon 40 grains, camphor 120 grains, castor-oil 5 drachms, and rectified spirit 32 drachms.

This may be used simply as a liniment, or sprinkled on some material like spongiopiline or even flannel, and applied as a mustard leaf would be.

The Uses of Mustard.—Mustard poultices are employed in pleurisy, inflammation of the lung, bronchitis, &c., to withdraw the blood from the interior of the chest. For these purposes the larger the poultice the better, and while the risk of raising a blister is to be carefully avoided, the skin should in a short time be made quite red. The effect should be kept up for a considerable period, 24 hours or more, by a judicious reapplication of the poultice at appropriate intervals. If the poultice is properly made and put on warm enough to act quickly as it ought to do, two or three poultices in the 24 hours ought to be quite sufficient. A poultice ought not to be kept on longer than 15 to 20 minutes at a time. If it is properly made it can hardly be borne longer, and if it is properly made a 10-minutes' application ought to be sufficient. Many people apply poultices and no redness of skin is perceptible after even an hour. This simply means that the mustard has not been active, either because it is bad or because the essential oil has been driven off by too great heat, or from some defect in application. A blister produced by mustard is painful and slow to heal, and always to be avoided. If a blister has been produced carron-oil (p. 844) is to be applied, and later zinc ointment.

Vomiting is often speedily relieved by a mustard poultice over the pit of the stomach; a mustard poultice applied to the nape of the neck will often remove headache very speedily; and a mustard poultice or leaf applied to the small of the back is very effective in relieving pain in that region, to which many people are subject after a fatiguing day's work or excitement. Large mustard poultices over the belly are required in pain there, specially if inflammatory mischief is threatened.

A mustard foot-bath is useful in common cold (see above) in relieving headache, in procuring sleep, to remove excess of blood from the head, and is very serviceable in cases of painful monthly illness. When the illness is arrested or suppressed, a mustard sitz-bath, each day during the time the discharge is due, is of value. Flying mustard poultices, a large mustard poultice applied for a few minutes, here and there, on different parts of the body, on the chest, belly, thighs, &c., are useful as a general stimulant in rousing a person suffering from opium-poisoning.

For hoarseness, inflammation of the windpipe or larynx, a mustard poultice ought never to be applied directly over the front of the throat. Owing to the thinness of the tissues intervening between the surface and the interior of the throat, only increase of swelling and a greater degree of hoarseness or difficulty of breathing would result from the rush of blood to the part. Particularly is this the case in children. Therefore the poultice ought always to be applied lower down, at the root of the neck or the upper part of the chest in front.

A tea-spoonful of mustard in a tumblerful of water is the dose for emetic purposes (see p. 851).

Turpentine has been already discussed on p. 872. It is largely used as a stimulating application to relieve pain and inflammation in affections of the chest and bowels, in neuralgia, lumbago, sciatica, &c. A good method of applying it is to sprinkle the turpentine on a piece of flannel, sufficient being used to damp the flannel. This is applied over the part of the skin to be acted on. Above this is put a thick pad, made of several layers of flannel, wrung out of water as hot as can be borne. The whole is secured by a broad bandage. It is to be kept on till the skin is quite red, but short of blistering, and it will blister when the vapour is confined in this way, if it be kept on long enough. The part may then be dressed with a layer of cotton wool secured by a bandage, or with a sheet of lint moistened with olive-oil.

Ammonia (see p. 843), the spirits of hartshorn, is employed as a counter-irritant in the same way as mustard or blisters. It may be applied sprinkled on flannel or lint, and it reddens the skin in a few minutes, when it should be removed.

Liniment of Ammonia, "Hartshorn and Oil," is best suited for this purpose, 1 part of hartshorn and 3 of olive-oil. This also is applied in flannel or lint.

The strong ammonia may be employed to produce a blister as follows:—Cut a piece of lint a little longer than the desired blister. On this pad pour 10 or 20 drops of the strong solution of ammonia, apply to the skin and cover with a good-sized watch-glass. In a short time, when the skin has become quite red, the lint is removed and a poultice applied, which raises the blister in from ten minutes to half an hour. It is, however, not quite certain, the skin of some not being blistered by it. Spanish-fly is much more reliable, and for the mere production of redness mustard is better.

The liniment is, however, an admirable stimulating liniment for painful and swollen joints, for stiff joints, for rubbing over sprained parts after all acute pain has ceased, and for similar purposes.

Iodine is described on p. 825. The preparations employed for external application are the tincture, the liniment (made with 5 parts of iodine, 2 of iodide of potassium, 1 of camphor, and 40 of rectified spirit), and the ointment. There is also a preparation called colourless iodine, made with iodine and hyposulphite of soda, which does not stain the skin. If the skin is not too tender two coats of the liniment should be painted on with a camel-hair pencil; but if the skin is delicate one coat is enough.

It is painted on the back of the chest in chronic pleurisy to promote the removal of the fluid accumulated in the chest cavity; and it is advised to be painted on the front under the collar bones to relieve the harassing cough of consumption. For the relief of pain a mustard poultice is better. It may be painted round chronically swollen joints, but small frequently repeated blisters are more serviceable. It ought never to be used by unskilled persons to paint over swollen glands. If any pain and tenderness exist in the gland the chance of exciting inflammation and the formation of matter is great (see p. 209); and many children are permanently disfigured by such a result. The ointment well rubbed over chilblains, so long as the skin is unbroken, is often sufficient to effect a cure in two or three days.

Spanish-flies.—This is the dried insect *Cantharis vesicatoria*, belonging to the beetle order, Coleoptera. It is indigenous to Southern and Central Europe, frequents chiefly trees and shrubs, such as ash, lilac, elder, and honeysuckle. It is from ½ to 1½ inch long and ⅕ to ⅓ inch broad, and of a shining metallic green colour. The beetles are collected in early morning by shaking them off the trees into white cloths spread below. They are killed by immersion in hot water and are then dried. They are reduced to powder, which is greyish-brown in colour and contains shining green particles. The chief preparations are:—

Tincture Cantharidis.
Blistering Paper (Charta Epispastica or Cantharidis).
Cantharides Plaster—Blistering Plaster (Emplastrum Cantharidis or Lyttæ).
Blistering Fluid—Liquor Epispasticus.
Cantharides Ointment.

This blister when applied to the skin first reddens and then causes the production of a large bleb filled with fluid. The blistering action is due to an active principle called **cantharidin**. The blistering plaster is spread on leather or adhesive plaster in a layer about the thickness of a sixpence, and the surface is lightly touched with oil. If the skin over which it is to be applied is washed with soap and water and then bathed with vinegar, the plaster will act better. If only a slight degree of action is wanted the blister should be removed in three or six hours, and a piece of carded cotton applied to the part; if more energetic action is wanted it should be left for 12 hours, and dressed, after the raised skin is snipped through, with lint soaked in oil. The blistering paper is less energetic than the plaster. The blistering fluid is applied by painting it over a portion of skin the extent of the desired blister, and then applying several hot poultices.

It is scarcely possible to indicate here when a blister is suitable and when it is not. It is needful to say that blisters should never be employed at haphazard, specially large blisters. They are very often far too readily employed. Specially in the case of the young and the old must they be used with discrimination, if used at all, the risks of destroying the skin in mass are so considerable. It is to be remembered that a very considerable depressing effect is produced on a person by the action of a blister, both on account of the fluid withdrawn from the blood and by the effect on the nervous system. The weakening effect will be all the more pronounced the larger the blister is. As a general rule it may be said that if blisters are resorted to in the absence of skilled medical advice, it is better to apply small flying blisters than large ones, that is a small blister—varying from the size of a shilling to that of a crown piece—may be applied to a particular spot on one day, a second in its neighbourhood the next day, and so on, each being allowed to heal as quickly as possible. Such blisters are applied on the temple and at the back of the ear for inflammations of the eye and ear; they are applied round swollen joints to remove pain and swelling, as at the knee-joint, at the nape of the neck to relieve giddiness and head symptoms, over the heart to relieve pain there, over the pit of the stomach to relieve vomiting, down the spine to relieve spinal irritation, and on the painful spots of a nerve to remove neuralgia. A long narrow blister down the back of the thigh is often useful in sciatica. In acute rheumatism large blisters applied round the limb above and below the affected joint are strongly advocated.

If taken internally, Spanish-flies produce marked irritation of stomach and bowels, with vomiting and purging, as well as severe inflammation of the kidney and strangury. Very large doses produce delirium, spasms, stupor, and death.

The application of large blisters is liable in many people to produce marked signs of irritation of the kidneys and bladder. This is supposed to be prevented by sprinkling the surface of the blister with finely-powdered camphor or by painting it over with tincture of camphor.

The stimulating effect which cantharides has upon the skin is made use of to promote the growth of hair. **Erasmus Wilson's Hair Wash** consists of vinegar of cantharides 1 part, glycerine 1, tincture of bark ½, orange-flower water 8, and rose water 8.

Poisoning by Spanish-flies is to be met by emptying the stomach by an ipecacuanha emetic and then giving large draughts of gummy water, oil and spirit being avoided, as they dissolve the active principle. To relieve irritation of kidneys and bladder, warm sitz-baths and opium are advised.

Croton-oil has been sufficiently referred to on pp. 861, 862.

Stimulating Liniments, Washes, and Ointments.

Stimulating liniments or **embrocations** are specially employed to relieve stiffness after inflammation or injury, to remove thickening and swelling when all acute pain has passed, and to restore the full use of the part. As a general rule these liniments are not to be employed until all active inflammation has passed. Thus suppose a person sprains an ankle or a wrist, rubbing and the application of any stimulating material could only aggravate the pain. It is rest and soothing applications, such as warm cloths, that are desired, and when all the acute results have passed, then rubbing with a liniment, gently at first, and then, after trial has shown it to be quite safe, more vigorously, will remove the remaining swelling, get rid of the stiffness, and restore the full use of the part.

The chief stimulating liniments are:—

Arnica Tincture.
Hartshorn and Oil—Liniment of Ammonia.
Camphorated Oil—Liniment of Camphor.
Compound Camphor Liniment (camphor 2½ ozs., oil of lavender 1 drachm, strong ammonia 5 ozs., rectified spirit 15 ozs.).
Iodine Liniment.
Soap Liniment.
Soap and Opium Liniment—Opodeldoc.
Compound Mustard Liniment.
Liniment of Turpentine (turpentine-oil 16, soft soap 2, camphor 1; dissolve the camphor in the turpentine and then rub up with the soap).

Arnica is the root-stock of *Arnica montana.* This is used for the tincture, and there is also a tincture of the flower-heads. It is used for bruises and sprains, but should not be rubbed on till after all acute pain has ceased, as it is capable of setting up inflammation.

Stimulating lotions are for ulcers, wounds, &c., which are slow of healing because of a defective blood supply. The ulcer or wound of this kind is pale in colour, smooth on the surface, not covered over with the little sprouting granulations which every healing wound shows. The edges are thick, white, and not sensitive, and the discharge is thin and scanty.

The chief lotion for such cases is the

Red Wash (sulphate of zinc 16 grains, spirit of rosemary and compound tincture of lavender, of each 2 drachms, water to 8 ozs.).

Other stimulating lotions are:—

Black Wash (30 grains calomel, ½ pint lime water).
Yellow Wash (18 grains corrosive sublimate, ½ pint lime water).
Sulphocarbolate of Zinc (2 grains to 1 oz. water).
Corrosive Sublimate (1 grain to 1 oz. water).
Chloride of Zinc (2 grains to 1 oz. water).

Stimulating Ointments are as follows:—

Boracic Acid and Carbolic Acid Ointments.
Creasote Ointment (p. 911).
Blue Ointment.
Red Precipitate Ointment.
Yellow ,, ,,
White ,, ,,
Citrine Ointment.
Scott's Dressing.
Chrysophanic Acid Ointment.
Iodine, Iodoform, and Tar Ointments.
Resinous Ointment.
Sulphur Ointment.
Chrisma Sulphur.
Zinc Ointment.

The three ointments that head the list are stimulating and antiseptic ointments. The blue, red, yellow, and white precipitate, citrine ointments, and Scott's dressing, are all mercurial preparations. The first four of them are all used to destroy insects.

The **Red and Yellow Precipitate** ointments are specially useful in inflamed conditions of the eyelids, being applied at night, and as a stimulant to chronic inflammatory eruptions of the skin.

The **Citrine Ointment** is similarly used.

Scott's Dressing consists of strong blue ointment 6 parts, yellow wax, and olive-oil, of each 3, and camphor 1½. The camphor in fine powder is added to the melted wax and oil when nearly cold, and the blue ointment next. It is applied to chronically inflamed and swollen joints. The dressing is spread on a sheet of lint, which is then cut up into strips, these are wrapped round the joint, one overlapping the other till the joint is completely enveloped. Strips of adhesive plaster are then applied in the same way as tightly as possible, and over all a starch bandage is applied. In two or three weeks it is removed, and the swelling will usually be found greatly subdued. If owing to diminished swelling the application becomes loose, it should be removed and reapplied.

Iodine Ointment may be used like the liniment for stimulating purposes, and is very useful for chilblains.

Chrysophanic Acid Ointment is made with chrysophanic acid or chrysarobin 1 part, and benzoated lard 10 parts.

Chrysophanic acid is derived from Araroba or Goa powder, a concretion from clefts in the stem of *Andira Araroba*, a leguminous tree imported from Brazil. It is an orange-yellow powder.

The ointment is very stimulating to the skin, destroys low vegetable organisms in the skin, and is very successfully used in scaly diseases such as psoriasis, and in ringworm. It stains the skin and clothing. Clothing containing starch it colours blue; therefore linen or cotton should not be worn during its use.

Iodoform Ointment is employed for foul ulcers, indolent sores, and unhealthy wounds.

Tar Ointments are specially resorted to in skin affections, in eczema, psoriasis, ringworm, prickly heat, and specially to relieve ringworm.

Resinous or **Basilicum Ointment** is a popular dressing for indolent sores. It is made of resin or colophony, the residue left from the various species of pine after distilling off the oil of turpentine. Two parts of resin in coarse powder, 1 part of yellow wax, and 4 parts of simple ointment are melted together with gentle heat, strained while hot through flannel, and stirred till cold. Simple ointment is made of 2 parts white wax, 3 of prepared lard, and 3 of almond oil melted together and stirred till solid.

Sulphur Ointment is used in itch, in eczema, ringworm of the head, and many other skin affections.

Chrisma is a petroleum preparation like vaseline, and has the property of dissolving sulphur. In consequence chrisma sulphur is more active than the common sulphur ointment. It is specially valuable in eczema, specially when found in the head and face of children, to which it should be freely applied, after the scabs have been removed by diligent soaking with water, or after softening with a turnip poultice.

Zinc Ointment is the common white "healing ointment." The oleate of zinc ointment is preferable to the common zinc ointment. It is made of 1 ounce of oleate of zinc and 1 ounce of vaseline, and may be made weaker, ½ or ¼ oz. oleate to the ounce of vaseline. This form is easily removed from the sore or ulcer, and does not coat it with an irritating crust. Besides for ordinary wounds and sores, it is often useful in chronic eczema.

Astringent Lotions and Washes.

Astringents are applied to the surface of the body to cause contraction of the part, to lessen discharge, to give a tone to the part, to cause ulcers and wounds to take on a more healthy action, to diminish their size, and make the healing surface less flabby and soft. Used as eye lotions they diminish inflammation and the flow of matter, as gargles or spray they lessen the secretion of phlegm and strengthen the throat, and as injections to the genital passages or womb they are used to lessen congestion and discharge. The chief astringents have already been discussed on p. 867 and two following pages in connection with their internal use in diarrhœa.

Borax and Alum Lotions, 2 tea-spoonfuls of the former to a pint of water, a tea-spoonful of the latter to a pint are useful astringent injections.

Catechu Lotion is made with 60 grains catechu to 8 ozs. hot water.

Oak-bark Lotion requires 2 ozs. of the bark to 1 pint of water, boiled down to a half.

The stimulating lotions mentioned above are useful for similar purposes or for the bathing of wounds.

For use as a gargle borax may be used, 120 grains to 1 oz. tincture of myrrh and 8 ozs. water; or borax 120 grains in 1 oz. glycerine, used as a paint to sores of mouth and throat.

Alum may be used as gargle, 80 grains to 1 oz. tincture of myrrh and 8 ozs. water, or tannic acid 35 grains, tincture of myrrh 4 drachms, and eau de cologne 1½ ozs., for soft and sore gums.

Chlorate of potash ¼ oz., tincture of myrrh and borax ½ oz., glycerine 1 oz., and water to

4 ozs. make a useful gargle for ulcerated throat and mouth.

For Sprays to the Throat, sulphurous acid ½ oz. to 1 oz. of water, or an increased strength up to equal parts, dried alum 3 to 20 grains to 1 oz. water, tannic acid 3 to 12 grains to 1 oz. water, borax 5 to 20 grains to 1 oz. water, chlorate of potash 5 to 10 grains to 1 oz. water, tincture of steel 5 to 30 grains to 1 oz. water, sulphate of zinc 3 to 15 grains to 1 oz. water, may all be employed.

Applications for Bleeding. — When astringent substances are applied to arrest bleeding they are called **Styptics.** Alum, catechu and oak-bark, borax, and tannin can all be used for this purpose. Hazeline is an admirable remedy for this purpose, and a solution of 1 grain sulphate of iron to 1 oz. water.

Styptic Colloid is a preparation made by saturating alcohol with tannin and then adding ether and gun-cotton. When painted over the part it stops the bleeding and leaves the surface protected by a film.

Matico Leaves, the dried leaves of *Piper angustifolia* from Peru, are used to arrest bleeding from small wounds, such as leech bites. The leaf contains tannin, and an infusion is astringent. Of the infusion the dose internally is 1 to 4 ozs., of a fluid extract (American) ½ to 3 tea-spoonfuls, and of tincture the same.

Compound Tincture of Benzoin, or Friars' Balsam, is the popular application for bleeding wounds. It is not cleanly enough.

Soothing Liniments, Washes, and Ointments.

The **Soothing Liniments** are employed to relieve pain. They are:—

Liniment of Aconite.
,, ,, Belladonna.
,, ,, Lime (Carron-oil, equal parts of lime-water and linseed-oil).
,, ,, Chloroform.
,, ,, Opium.

The liniment of aconite is used in neuralgia and sciatica, rubbed along the course of the affected nerve, and for painful and swollen joints, and it is rubbed over muscles in muscular rheumatism. The liniment relieves pain by diminishing the sensibility of the part. Great care requires to be exercised lest some becomes absorbed and affects the general system (see p. 834). Belladonna liniment is similarly employed, and is often mixed with aconite liniment as well as with liniment of chloroform.

Carron-oil is the most soothing application for burns.

Liniment of opium or soap and opium liniment is used for painful swellings, lumbago, &c.

Soothing Lotions, &c. are:—

Lead Lotion, or Goulard's Lotion.
Opiate Lotion (30 grains powder of opium, 8 ozs. boiling water; strain after 2 hours).
Poppy Lotion (extract of poppy 120 grains, 4 ozs. boiling water).
Conium Lotion (60 grains extract of conium, 3 ozs. water).
Belladonna Lotion (20 grains extract of belladonna, 4 ozs. water).
Glycerine.

All these may be applied to irritable sores, sores which fail to heal from excess of action (see p. 366), and which are hot, tender, raw-looking, and painful. There is a thin acrid discharge, and they bleed on the slightest touch.

Soothing Ointments, which are used for similar purposes to the soothing lotions, are:—

Atropine and Belladonna Ointment.
Aconitia Ointment.
Gall and Opium Ointment.
Acetate of Lead Ointment.
Marsh-mallow or Althæa Ointment.
Veratrine Ointment.
Vaseline.
Lanoline.

The uses of these have been sufficiently indicated by what has been said above.

The aconitia ointment is not to be used without medical advice; its strength as a poison is so great.

Gall and opium ointment is not only soothing but astringent, and is used for piles.

The acetate of lead ointment is one of the most useful of these applications.

Veratrine ointment acts like aconite, diminishing the sensibility of the nerves of the skin, and is used for neuralgic affections.

Vaseline or Petroleum Ointment is a substance obtained by distilling off the lighter portions of American petroleum. It does not become rancid, and is a protection to all raw surfaces.

Lanoline is a purified fat obtained from sheep's wool. It may be used as vaseline or simple ointment is used. It is very largely used as a basis for ointments, since it is readily absorbed by the skin, and drugs mixed with it and rubbed on the skin enter the system much more rapidly than if mixed with ordinary lard or vaseline. **Agnine** is the term applied to a similar substance in America.

SECTION X.—MINERAL BATHS AND WELLS.

The Action of Pure Water on the Body.

The Action of Mineral Waters on the Body.

Classification of Mineral Waters:

Indifferent Waters—Thermal Springs;
Common Salt Waters—Simple Saline Waters—Muriated Saline Waters;
Bitter or Aperient Waters—Sulphated Waters;
Soda or Alkaline Waters;
Muriated Alkaline Waters—Soda Waters with Common Salt;
Sulphur Waters;
Lime Waters—Earthy or Calcareous Waters;
Iron Springs—Chalybeate Waters;
Iodine and Arsenical Waters.

Routine of Life at a Spa—Bath-fever.

Indifferent Waters—Thermal Springs—Wildbäder:

Acqui—Badenweiler—Bagnères de Bigorre—Bath—Bormio—Buxton—Gastein—Hammam Meskoutin—Hammam R'Irrha—Hot Springs (Arkansas and Virginia)—Johannisbad—Landeck—Leukerbad (Leuk, Lœche-les-Bains)—Liebenzell—Lucca—Luxeuil—Matlock—Neris—Neuhaus—Panticosa—Pfäffers—Plombières—Ragatz—Römerbad—Schlangenbad—Teplitz—Tobelbad—Tüffer—Warmbrunn—Wildbad.

Common Salt Waters—Muriated Saline Waters—Sool Baths:

Adelheidsquelle—Baden-Baden—Bex—Bourbonne-les-Bains—Canstatt—Cheltenham—Cronthal—Dipso or Aedepsos—Droitwich—Dürkheim—Hall—Heilbrunn (Adelheid Spring)—Homburg (Elizabeth Spring)—Ischia—Ischl—Iwonicz—Kissingen (Rakoczy Spring)—Kreuth—Kreuznach—Leamington—Mergentheim—Mondorf—Nauheim—Neuhaus—Pyrmont (Salt Spring)—Rehme Oeynhausen—Reichenhall—Saratoga (Empire Spring)—Schmalkalden—Soden (Nassau, and near Aschaffenberg)—Thermia—Wiesbaden—Wildegg—Woodhall.

Bitter Waters—Aperient or Sulphated Waters:

Aesculap—Bedford Springs—Bertrich—Birmensdorf—Carlsbad (Sprudel)—Cheltenham—Elster—Epsom—Franzensbad (Franzensquelle)—Friedrichshall—Füred—Hunyadi Janos—Leamington (Saline Spring)—Marienbad (Kreuzbrunnen)—Mattoni's Royal Hungarian Bitter Water—Mergentheim—Ofen or Buda—Püllna—Purton—Rohitsch (Tempelbrunnen)—Rubinat—Saidschütz—Scarborough Wells—Sedlitz—Stubuya—Tarasp (Great Spring)—Victoria-Ofner.

Simple Soda Waters—Alkaline Waters:

Apollinaris—Bilin—Desaignes (Eau de César)—Fachingen—Fellathal—Geilnau—Gerolstein—Gettysburg—Giesshübel—Kronenquelle—Mont Dore—Neuenahr—Preblau—Salzbrunn—Saint Marco—Soulzmatt—Vals—Vichy—Chaudes Aigues—Evian-les-Bains—Néris—Teinach.

Soda Waters with Common Salt—Muriated Alkaline Waters:

Birresborn—Ems—Gleichenberg—Kainzenbad—La Bourboule (Choussy)—Luhatschowitz—Roisdorf—Royat—Selters—Vic-sur-cère.

Sulphur Waters:

Abano—Aix-les-Bains—Aix-la-Chapelle (Kaiserquelle)—Allevard-les-Bains—Amélie-les-Bains—Ax—Baden (Austria and Switzerland)—Bagnères de Luchon—Barèges—Battaglia—Buffalo Lithia Springs—Builth—Burtscheid—Cauterets—Challes—Eaux Bonnes—Eaux Chaudes—Eilsen—Enghien—Grosswardein—Gurnigel—Harkany—Harrogate (old sulphur well)—Helouan—Heustrich—Kainzenbad (Gutiquelle)—Spring at Kreuth—Langenbrücken—Le Vernet—Llandrindod—Llanwrtyd—Lisdunvarna—Mehadia—Meinberg—Moffat—Nenndorf—Panticosa—Pystjan (Posteny)—Saint Sauveur—Schinznach—Stachelberg—Strathpeffer (upper well)—Töplitz Warasdin—Uriage—Weilbach—White Sulphur Springs (West Virginia, U.S.).

Lime Waters—Earthy or Calcareous Waters:

Alet—Bethesda—Buffalo Lithia—Chateldon—Condillac—Contrexéville—Couzan—Cransac—Inselbad—Johannisbrunnen—Leukerbad (Lorenzspring)—Lippspringe—Lucca—Poland Spring—Pougues—St. Galmier (Source Nouvelle)—Sulis—Taunus—Weissenburg—Wildungen.

Chalybeate Waters:

Arapatak—Alet—Alexisbad—Altwasser—Antogast—Bartfeld—Bocklet (Stahlquelle)—Brückenau—Bussang—Cudowa—Driburg—Elster—Flinsberg—Franzensbad—Freienwalde—Freiersbach—Godesberg—Griesbach—Gonten—Harrogate—Heinrichsbad—Hofgeismar—Imnau—Kainzenbad—Kœnigswarth—Liebenstein—Liebwerda—Lobenstein—Muskau—Niederlangenau—Orezza—Petersthal—Pyrmont—Recoaro—

Reinerz—Rippoldsau—Santa Catarina—Schandau—Schwalbach—Shelfanger—Spa—St. Moritz—Sternberg—Tunbridge Wells—Vichnye—Wiesau—Wildungen.

Iodine Waters.

Arsenical Waters.

Whey and Grape Cures.

Mineral Baths and Wells.

The chief purpose of this section is to mention all the chief natural mineral waters now so commonly resorted to for the improvement or preservation of health, and for the treatment of disease, to note the chief constituents of these waters, and the effects they are supposed to produce, and to indicate the diseases for which they are employed. Mineral springs and wells are now so numerous that it is impossible in the space at our disposal to devote even a few lines of consideration to each. The plan will, therefore, be followed of classifying them according to their chief constituents, which will be to some considerable extent also a classification according to their uses. All the springs and waters which are in use to any extent can thus be arranged in a series of tables, and only the chief of them will be selected for further remark.

Nearly all of the springs are employed for bathing as well as for drinking purposes. In Part II. Section V. p. 732, and subsequent pages, sufficient has already been said regarding baths, and no further special consideration need be given to that subject. The waters which are employed for bathing purposes will, however, be mentioned, and their manner of use indicated as we go along, though the chief object of the section is to consider their effects when imbibed. We must first give some attention to the general effects of water on the body.

The Action of Pure Water on the Body.—By pure water we mean here not water chemically pure, but such water as is ordinarily used for drinking purposes. The nature of such water has been already discussed in Part II. Section II. p. 634. We have seen that the human body consists of water to the extent of 61 per cent (p. 535). Water is necessary to chemical changes going on, and the water removed from the body in the breath, in the sweat, in the urine, and by the bowels is the vehicle, so to speak, by which are removed from the organism the waste products of the chemical actions going forward in the body necessary to continued life and activity. As a general rule, the more active a tissue is, the greater is the amount of water it contains; thus, while bone contains only 48½ per cent of water, the gray substance of the brain contains nearly 86. Within certain limits, therefore, an increase in the amount of water taken will lead to increased activity of tissue change. If we take, for example, the water expelled by the kidneys, we find that, corresponding to an increase in the quantity imbibed, there is an increase in the output by these organs. The water thus expelled is more dilute, contains less substances in solution than an equal quantity of such as was expelled when only an ordinary amount of water was being taken, but if the quantities be collected for 24 hours, it is found that the total quantity of solids removed by the more dilute urine is in excess of that removed by the more concentrated. In short the drinking of an increased quantity of water has caused the removal of more waste from the body. There is a like increase in the waste removed by other channels, the skin, for example. An increase in the quantity of water drunk also will increase the quantities of digestive juices secreted, and to some extent assist the digestion; in particular it increases the production of bile. There is no doubt of its value in the stimulus thus given to removal of waste from the liver, and in the relief thus afforded to that organ.

In the deliberate use of larger quantities than usual of water, there are three circumstances worthy of special attention: (1) the time when the water is taken, (2) the rapidity of drinking—the quantity, in other words, taken at a time, and (3) the temperature of the water. As regards the time, water is more quickly removed from the stomach and passed into the vessels going to the liver when the stomach is empty. On this account the morning, before breakfast, is the time usually chosen. As regards the quantity, if a large quantity is introduced into the stomach at a time, absorption is apt to be slow, and discomfort likely to be experienced. The waters should, therefore, be sipped slowly. The person after sipping one glass walks up and down some verandah or pathway, engaged in pleasant conversation it may be, and in ten or fifteen minutes takes a second glass, and so on till he has consumed an appropriate supply. If he is unable to take as large a supply as is desired at one time, a further quantity may be taken before the midday and afternoon meals. As regards the temperature, waters taken warm, as

near as possible to the temperature of the blood, are less stimulating to the stomach and bowels, but the warmth promotes their absorption, and conduces, therefore, to their action on the blood and distant organs. When cold waters produce a loaded feeling of the stomach, this will be overcome by slightly warming them. If the waters are taken with the intention of stimulating the stomach and bowels, not so much for the purpose of being absorbed into the circulation, they are best taken cold. Mineral waters taken, for example, for constipation are best thus, and simple cold water taken on an empty stomach in the morning is often sufficient to secure an aperient action. Ice-cold water, again, is a most pronounced sedative to the stomach, but it must be sipped only in small quantities. Hot water also is soothing, and useful in painful affections. Moreover it stimulates the liver, and is a powerful aid to the removal of bile from the liver, for which, as well as for its general calming effects, it is taken in the evening.

Now if we sum up all these numerous effects of simple ordinary water drunk in early morning at a spa—the cleansing effects on kidney and skin, the increased removal of waste products, the stimulus to increased tissue change, the stimulus to the stomach, the washing out, so to speak, of bile from the liver, the restoration of regular function to the bowels—and if we add to all these the complete change of air and of scene, the complete change of occupation, of habits, and of companions, the cessation of hurry and worry, and of the accustomed routine of daily duties, we can easily understand how rapidly beneficial may be a brief stay at a spa, especially to the worn-out man of business or professional worker.

It is due undoubtedly to the circumstances indicated that many spas have obtained their repute; for a large number of the waters, as we shall see, contain no more solids than does ordinary drinking water from lake or river, and they are, therefore, called **indifferent waters.** One ingredient the most of these waters possess, namely carbonic acid gas. Bubbling up from a deep subterranean source, they cannot fail to be charged with such gas, as we have already explained on p. 651. Its effect upon the stomach is largely a mechanical one. The gas given off from the liquid in contact with the stomach walls appears gently to stimulate the circulation in the walls of the stomach, while a soothing effect seems also to be produced on the nerves. Whether that be due or not to the chemical action of the gas, it is not possible to say definitely. It is certain that an aerated water is often retained in the stomach when other materials, plain water among them, are rejected. The stimulating effects of the escaping gas act also upon the bowel, and simple aerated water will frequently prove effectual in constipation when plain cold water, and even purgative mineral waters, have no effect.

The Action of Mineral Waters on the Body.—While many of the spa waters contain no more, and some even less, solids in solution than common drinking water, most of them contain considerably greater quantities of saline material, some of them so much that they cannot be used for drinking or even bathing purposes without dilution. Among the principal ingredients of mineral waters are the following:—

Common salt (chloride of sodium).
Chloride of potassium.
,, magnesium.
,, lime.
Carbonate of soda.
,, potash.
,, magnesia.
,, lime.
,, iron.
Sulphate of soda (Glauber's salts).
,, magnesia (Epsom salts).
,, lime.

Besides these there are phosphates, compounds of bromine and iodine, arsenic, aluminium, strontium, lithium, barium, silicon, fluorine, nitrates, &c., and besides oxygen, nitrogen, and carbonic acid gas, sulphuretted hydrogen, ammonia, and others. A great variety of substances is contained in many mineral waters; and chemists are now able to detect the presence of substances which exist only in infinitesimal quantity. The minute quantity in which many ingredients are present renders it unlikely that they have any effectual share in the action of the water when taken into the system. On the whole, the character and effects of any given water are usually found to depend upon the two or three ingredients which it has in greatest amount. So that when a chemical analysis is placed before one it is comparatively easy to determine what the action of the water is likely to be, and under what circumstances it is likely to be useful. It is true that while chemists can analyse a mineral water, and determine the quantities in which the various ingredients are present, they cannot manufacture a mineral water which will produce the actual benefits of the natural product. But it must be remembered that the best results from

the waters are produced at the springs, where a great many attendant circumstances exist which make for health, and that if the natural waters bottled and used at home are not nearly so efficacious as those drunk at their source, it is because of the absence of these other favouring conditions. Further, though the chemist can accurately enough determine to the fraction of a grain the amount of sodium, potassium, magnesium, calcium, chlorine, nitrogen, oxygen, &c., present in a water, he cannot tell with anything like absolute certainty in what manner the elements are combined. Though he knows to a nicety the quantity of chlorine, sodium, potassium, &c., present, it is on theoretical grounds that he determines how much of the chlorine is in combination with sodium as common salt, how much in combination with potassium as chloride of potassium, &c. Therefore arises the difficulty, indeed the impossibility, of producing an exact imitation. In spite of these circumstances it is possible to classify mineral waters according to their chief constituents. Such a classification will have the advantage of at least indicating the chief effects the waters are likely to have on the body.

Classification of Mineral Waters.

I. First of all are the waters which contain so little solids of any kind that the effects they produce are due simply to the pure water itself. These are called **indifferent waters.** They are mostly obtained from warm springs, and they are mostly charged with carbonic acid gas.

II. The next class is of those whose principal ingredient is common salt, chloride of sodium. **Common salt waters, simple saline waters, muriated saline waters,** are all terms for this class. Some of them are warm, some are cold; most contain carbonic acid gas in some quantity.

III. A third class contain as their chief ingredient Epsom or Glauber's salt, the sulphate of magnesia or soda. These are because of their chemical character called **sulphated waters,** because of their taste **bitter waters,** and on account of their action **aperient waters.** Some of them contain one or other of the salts named or both, and no marked amount of other ingredients. Others have also notable amounts of both common salt and carbonate of soda. Hence the latter are sometimes distinguished by being called **alkaline sulphated waters.**

IV. In another class of waters the chief chemical characteristic is due to the presence of carbonate of soda or potash. These are the **simple soda or alkaline waters,** resorted to because of their antagonism to acid, in acidity of stomach and bowels, in gout, &c.

V. Other waters whose chief ingredient is also carbonate of soda contain besides common salt with carbonic acid gas. They are therefore called **muriated alkaline waters.**

VI. Then there are the **sulphur waters,** characterized by the presence in solution of that foul-smelling gas, sulphuretted hydrogen, or other sulphur compounds, much resorted to in liver and skin affections, in rheumatism also and gout.

VII. There are waters whose chief ingredient is lime in the form of carbonate or sulphate, as well as magnesia carbonate. These are the chalky, earthy, or **calcareous or lime waters.**

VIII. **Iron or chalybeate waters** are those in which the quantity of iron present is such as to confer upon the water its chief value for states of poverty of blood (anæmia), &c.

Some waters contain iodine or bromine or arsenic in such quantity, though still minute, as in the estimation of some to be endowed with special properties, and to be worthy of being characterized as **iodine waters, bromo-iodine waters, arsenical waters,** and so forth.

In each of the classes named, omitting the first, the information as to the chief ingredient or ingredients supplied by the name is an indication of the effects the water is likely to have and the purpose for which it may be used, as will be shown in the consideration now to be given to each class.

Routine of Life at a Spa.—The mere drinking of the waters of a spa or the taking of a course of baths is not the whole, not even the half, of the spa cure. To the change of scene, to the freedom from business cares, of which we have already spoken, must be added the strictly regular habits of life, the return to natural modes of living, and the simplicity of diet, which are all essential parts of a proper course of baths or mineral waters at a health resort. No one, who visits such a resort for the restoration of health, thinks of carrying with him the highly elaborate and artificial habits of life out of which he can hardly extricate himself at home. The visitor first of all, on arrival at the spa, consults one of the local physicians who is well acquainted with the action of the waters of the place and knows how to employ them to best advantage in each particular case. He has laid down for his guidance careful rules as to the waters to be drunk, the baths to be taken, the diet to be employed, the exercise to be engaged in, and if he be a wise man he will follow out the directions to the letter. The usual routine is

something like the following:—The patient rises at 6 a.m. or earlier, and betakes himself to the spring not later than 7 o'clock. He drinks one glass of the water, and walks for 15 minutes; then he drinks a second glass and again promenades for 15 minutes. A third glass follows and is succeeded by another walk of 15 to 30 minutes or longer, the time taken to return to hotel or lodgings being counted as part of the time. He then rests for half an hour or so, passing the time in agreeable conversation or some light occupation. Breakfast is taken at 9 a.m., a simple easily digested meal, often, as at Carlsbad, nothing more than one or two light rolls and coffee, and it is frequently taken in the open air in the gardens of a *café*. A little time after breakfast a walk or pleasant excursion is the rule, terminating, at any rate, half an hour or more before dinner to permit of rest before the chief meal of the day, which is at 1 o'clock or half-past 1. The meal is varied enough, its exact character being, however, prescribed by the physician. In the afternoon a second course of water-drinking may be prescribed. If so, it is usually between 4 and 5, the first glass being followed by a 15-minutes' walk and a second glass by a walk of half an hour or more. At 7 p.m. or 7·30 a light supper is taken; and the visitor goes to bed not later than 10 p.m. These are the general rules; but, of course, they are subject to variations in accordance with the strength of the individual. Thus while, as a rule, the water is taken on an empty stomach in the morning, if a patient feels too feeble to do so and to take so much exercise without food, he is allowed, before going to the spring, a cup of bouillon, or a glass of milk, or a cup of coffee and a small piece of bread; and many patients add to the waters milk or whey.

Baths are most frequently taken between 11 and 12 o'clock, or between 2 and 4 afternoon, or as near to these hours as can be arranged so that the time for bathing be pretty nearly equidistant between the hours for meals.

At many of the principal spas a long covered way is provided in which patients may take the prescribed amount of walking exercise during wet weather, while the time is made to pass pleasantly by the playing of varied selections of music by the instrumental band, which is one of the invariable accessories of a popular resort. The band plays usually at the spring for an hour or two in the morning, and for a similar time in the afternoon or evening. At Homburg, to suit English habits, there is lunch at 1 or 1·30 p.m., and dinner at 6 or 6·30 p.m. The evening performance by the band begins at 7·30 p.m.; and when the weather is unsuited for out-of-door performance, it takes place in a well-appointed concert-hall. It may be added that a course at a spa is usually prolonged for from three to six weeks, but varies according to the requirements of each individual patient.

Well-fever or **Bath-fever** is a feverish condition which sometimes arises with excessive use of waters or unduly prolonged or too hot baths. Giddiness, drowsiness or sleeplessness, a feeling of cold followed by heat and sweating, rashes on the skin, are some of the symptoms produced, which at one time were regarded as part of the necessary result of the treatment, and the indication of the system being affected by the treatment. Concerning this Braun says: "From the misuse, both as to quantity and temperature of waters taken medicinally, there result in many cases various conditions of indisposition, differing according to the individual concerned, and most unsuitably comprised under the mystical common designation of well-fever. A well-fever does not exist, any more than does a well spirit; and what is generally understood by the term are individual conditions, in consequence of a lasting or transient exaggerated effect produced by the method, diet, and new mode of life, often, of course, combined with excitement of the system, but without common, characteristic, and constant symptoms. Deluging the stomach with water very easily produces dyspepsia and catarrh of this organ; and the special peculiarities of the liquid, its cold or heat, and the different salts and gases contained in it, heighten and modify this influence; digestion suffers, nutrition fails, the skin is subject to various eruptions, especially boils, and from the general state of health the symptoms of the general malady are increased." Waters which contain little or no salts in solution produce such symptoms as readily as strong waters, if their employment is overdone. They are very frequently observed at Buxton and Gastein, whose waters are even purer than ordinary drinking water. These are the reverse of desirable results, and are to be avoided by medical advice being sought and followed in the use of the waters.

I. Indifferent Waters (Simple Thermal Springs—Wildbäder).

There are waters termed indifferent because they possess no particular chemical characters because of absence of solid constituents in any quantity. Some are even purer than ordinary lake or river water, used for drinking purposes.

They are perfectly transparent, and devoid of taste. These waters are very largely used for bathing purposes, the constant supply of hot or warm water from the spring being taken due advantage of, swimming baths being arranged as well as sitz and foot baths, &c. It does not appear that they have effects beyond those due to the warmth of the water. Many of them contain gases in solution, and the escape of the gas in the water is accompanied by a gently stimulating action on the skin. Most of these springs rise at considerable elevations in hilly regions, and on that account have been called wild-baths (Wildbäder), *Aquæ Ferinæ* or *Thermæ Silvestres*, and the mountain climate is to be taken into account in estimating their effects. The waters when drunk have the effects of pure water already described, and they may be taken as hot as possible from the spring or may be allowed to cool.

Such waters are used as baths for their calming and soothing effects, and are found beneficial in nervous cases, cases of neuralgia, hysteria, excitability of the nervous system, sciatica, and painful menstruation. In rheumatic affections and in gout, specially in irritable forms, their soothing effects and their influence in aiding the removal of thickenings and swellings are valuable. But this is not an exclusive property of this kind of bath. In skin affections they are prized. They are employed also in abdominal affections, such as are accompanied by chronic thickenings finding much relief from such treatment. In some forms of paralysis, such as that following diphtheria or consequent upon lead-poisoning, they often produce benefit. Such waters are taken internally to soothe irritability of stomach and bowels, to stimulate the action of the liver and promote the secretion of bile, to correct acidity of the stomach and constipation. In general states of ill-health and in retarded convalescence the waters are useful because of the promotion of tissue change, and the warm baths aid their action. Such baths and waters are also useful to persons who, not suffering from any organic disease, are exhausted and their vital powers lowered by excessive work or the fatigues of ultra-fashionable life. In such cases the well-directed life of the bathing establishment, with its regularity, its quietness, its mountain air, and the calming influences of the warm bath on the nervous system, and at the same time its gently stimulating effects on the skin and circulation, with the change of tissue it promotes in association with the drinking water, are all well adapted to promote a restoration to ordinary healthy activity.

The table No. I., page 926, contains the names of the chief springs whose characters have just been described, their situation, elevation above sea-level, and the temperature of the springs being also noted.

We must now give a few details regarding the more important of these springs.

Bagnères de Bigorre (1850 feet), on the Adour, in the Hautes Pyrénées, is included among the indifferent waters, since it contains barely 10 grains of solid constituents in 16 ounces, of which nearly 6 consist of sulphate of lime, not absorbed if the water is imbibed. It is one of the most popular baths in France. It possesses no less than twenty-four springs, two of which, the Foulon and the Salut, are used for bathing purposes to diminish excitability of the nervous system. Three of the springs contain carbonate of iron, nearly $\frac{2}{7}$ grain in 16 ounces in one of them, these waters also being at a high temperature. These are used in cases for which iron is suitable (see p. 947). The accommodation is good, and the situation beautiful. It is reached in $5\frac{1}{2}$ hours from Bordeaux.

Bath, in the county of Somerset, England, was at one time a most popular and fashionable resort, and after a period of neglect efforts are being made to restore it to something like its old estate by the provision of every possible aid to the comfort and pleasure of visitors. It has four springs (swimming bath 88°, king's 110°, queen's 112°, hot 118°). The waters are practically indifferent, containing barely 18 grains of solids to the pint, of which 10 are sulphate of lime, $2\frac{1}{2}$ sulphate of soda, $2\frac{1}{2}$ chlorides of sodium (common salt), and of magnesium, and $1\frac{1}{3}$ carbonate of lime. A minute quantity of oxide of iron is also present. The waters are recommended for rheumatism and gout, chronic skin diseases, as psoriasis and eczema, dyspepsia, and neuralgia; of the water $\frac{1}{2}$ to 2 tumblerfuls are taken once or twice daily. The advantage of Bath is that it is available the whole year. It affords, indeed, one of the best winter climates in England, and is resorted to rather between November and April than in summer, when it is too relaxing. Its disadvantage is that it is a large town of about 52,000 inhabitants, but the accommodation is in consequence of a wider variety, and its bathing establishments are good.

The mineral water of Bath is bottled for use as a table water under the title **Sulis**.

Buxton, in Derbyshire, England, at an elevation of 1000 feet, has an abundant supply of very pure water, containing only $2\frac{1}{4}$ grains of

solids in 20 ounces of water, with ½ cubic inch of carbonic acid gas, but 60 of nitrogen. Its air is pure and bracing, but the temperature is very variable, and the rainfall rather excessive. The water is chiefly used for bathing, five minutes' immersion in the natural bath, fifteen minutes' if its temperature is artificially raised to 93° or 96°. In chronic gout and rheumatism, especially with debility, it is most useful. Of the water 2 or 3 pints are drunk throughout the day, part an hour before breakfast, the rest early in the afternoon. Buxton is not a very desirable place for the very enfeebled or delicate. The risk of catching cold, owing to the variableness of the climate is considerable; and the hilly character of the situation does not admit of any extent of level walk for the real invalid. The season is from April to November.

I. SIMPLE WARM WATERS (THERMAL SPRINGS).

Name.	Situation.	Temperature in Degrees Fahrenheit.	Elevation in Feet.	REMARKS.
Acqui	Italy	103 to 113 and upwards.		Mud-baths also.
Badenweiler	Baden	69 to 81·5	1,425	Whey-cure also.
Bagnères de Bigorre	France (Pyrenees)	90 to 95	1,850	
Bath	England	88 to 118	100	Contains ·03 gr. oxide of iron in 20 ozs.
Bormio	Italy	90 to 104 and higher.	4,300	Season, May to September. For chronic rheumatism and hysteria. Via Innsbruck, Bozen, Meran, and Stilfserjock.
Buxton	England (Derbyshire)	82	1,000	
Gastein	Austrian Alps	96·8 to 114·8	3,315	
Hammam Meskoutin	Algeria	115 to 213		Season, May to October. For rheumatism, gout, malaria, skin-disease, and old gunshot wounds.
Hammam R'Irrha	Algeria	Hot.		
Hot Springs	Arkansas (America)	93 to 150		
Hot Springs	Virginia ,,	78 to 110		
Johannisbad	Bohemia	86	2,000	
Landeck	Glatz in Silesia	66 to 84	1,400	Season, May to October.
Leukerbad (Leuk, Lœche-les-Bains)	Switzerland	102 to 122	4,600	
Liebenzell	Wurtemberg	71·5 to 77	1,113	Contains $\frac{1}{10}$th gr. carbonate of iron.
Lucca	Italy	100 to 129		Season, June to Sept. For chronic rheumatism and skin-diseases. Contains 7 to 13 grs. sulphate of lime.
Luxeuil	Haute-Saône (France)	65 to 133	1,300	
Matlock	England (Derbyshire)	68		
Néris	France	114 to 125	800	For neuralgia, hysteria, rheumatism, and uterine complaints.
Neuhaus	Styria	95	1,200	Whey-cure pursued here also. Season, May to October.
Panticosa	Spain (Pyrenees)	77 to 92	5,000	The highest bath in Europe. A resort in consumption. Season, July to September.
Pfäffers	Switzerland	100.4	2,115	
Plombières	France	66·2 to 143·6	1,310	
Ragatz	Switzerland	100·4	1,510	
Römerbad	Styria	94 to 98	750	Near Tüffer. For hysteria and chronic uterine disease.
Schlangenbad	Nassau (Prussia)	86 to 90·5	900	Mud-baths also employed here.
Teplitz	Bohemia	99·5 to 108·5	648	
Tobelbad	Styria	77 to 83	1,200	
Tüffer	Styria	95 to 102·2	712	Akin to Schlangenbad and Römerbad. Whey-cure also.
Warmbrunn	Silesia (Prussia)	96·8 to 104	1,100	
Wildbad	Wurtemberg	93·2 to 102·2	1,323	

Gastein (3315 feet) is the chief German spa of the kind we are at present considering. In the Tyrol, thirteen hours' drive from Salzburg, in the midst of mountain scenery, it possesses a high reputation for its bracing climate. Rain is heavy in June, July, and August, and the temperature is variable though never very high, the highest being 86° Fahr. The most appropriate season is from the middle or end of July to the beginning of September. The water contains only 2½ grains of solids in 16 ozs., of which 1½ grains are sulphate of soda, so that it is a very soft water. Its high altitude allows the water to be used for bathing at a higher temperature, less excitement being produced than the same heat of water would cause at a lower elevation.

The duration of the bath varies from ten minutes to an hour, and it is suited for chronic rheumatic and gouty conditions especially in nervous and irritable subjects. Gastein has also a reputation for hysteria, some forms of paralysis and impotence. At **Hof-Gastein**, 500 feet lower, and an hour's distance by the road, more accommodation is obtained, and thither the water is conveyed.

Leukerbad (4600 feet) is situated at the foot of the Gemmi Pass in the canton Wallis, and is reached by a railway journey of six hours from Geneva and a road journey of three hours. The waters are classed as indifferent, though they contain 14 grains of solids to 16 ounces; of which, however, 10½ are sulphate of lime, and 2½ are sulphate of magnesia. The baths are employed chiefly in chronic skin disease, the duration of the bath extending from half an hour to eight hours. The bathers are attired in woollen mantles and capes, and pass the time in the bath playing dominoes and chess, taking luncheon, &c., on boards floated to them. Both sexes bathe together, chiefly Swiss and French. The season is from June to September.

Matlock, in Derbyshire, England, has water of a temperature of 68°, but is chiefly famous for its hydropathic establishment, where the system of bathing with hot and cold water is carried out in a scientific manner, probably unsurpassed anywhere.

Pfäffers and **Ragatz,** in the Swiss canton St. Gall, are an hour's walk from one another. The latter is a station on the railway from Rorschach to Chur, on the way to St. Moritz. The waters of Pfäffers are conveyed to Ragatz in wooden pipes. They are used for both bathing and drinking, and are adapted for nervous affections in women, for gout and rheumatism.

Plombières (1310 feet) is situated in the department of the Vosges south of Nancy, and distant from it four hours by railway, and is in France what Teplitz is in Germany. The waters are drunk to the extent of five to six glasses, are easily borne by the stomach, and are useful in chronic catarrh and painful conditions of that organ. The bathing establishments are commodious, and the surroundings in the way of scenery and amusements are pleasant and cheerful. Rheumatism, chronic joint affections, neuralgia, are also treated. Hot baths continued for some hours are used.

Schlangenbad (900 feet) is situated in a valley of the Taunus. Its railway-station is Eltville, and it is near Wiesbaden and Schwalbach. "It is one of the places best suited for the mild, soothing, and refreshing effect of thermal treatment" (Braun). "It is as picturesque as a place can be on the small scale, with shady alleys and endless forest paths. The baths . . . are beautifully arranged, and I can vouch for their pleasant feeling, though I leave it to the fair sex to vouch for their cosmetic properties. They have a great reputation for quieting and strengthening the nervous system, and are resorted to very much by hysterical ladies, and ladies suffering from functional derangements of the uterine system. Skin complaints are also treated here" (Macpherson). The season is May to October.

Teplitz (648 feet) is on a branch from the railway between Dresden and Prague. It is one of the most frequented baths in Europe, and with its newer suburb of **Schönau** affords a total of 4000 baths daily. The town, which is situated in a broad and pleasant valley, surrounded on all sides by hills, has a population of 16,300; its climate is mild, vegetation is luxurious, and the neighbourhood abounds in interest. The springs are numerous, the chief one containing scarcely 5 grains in 16 ounces, of which 2½ grains are carbonate of soda. The baths are given as hot as can be borne, and are employed for all such purposes as have already been indicated on p. 924—rheumatism, gout, &c.—and have a special reputation for old gunshot wounds. They sometimes induce a feverish condition, attended by skin eruptions (see Bath-fever, p. 924). Mud or moor or peat baths are used here also. The season begins in May.

Wildbad (1323 feet), lies in the Black Forest, south of Carlsruhe, and distant from it a railway journey of two hours. It lies in the pine-clad ravine of the Enz; and has a population of 3200. It "has almost everything that can recommend a place to the English." It can be reached from London by Paris and Strasburg in twenty-four to thirty hours. The accommodation and bathing arrangements are excellent. It also, like Teplitz and Gastein, may be taken as a type of the thermal spring, in its effects in rheumatism, gout, depressed conditions of general health, and so on. Various kinds of paralytic cases are specially to be found here. **Liebenzell** is within 8 miles of Wildbad, and **Teinach**, also with mineral springs, cold, one of which contains iron, is 15 miles distant.

Among other places which possess springs, which contain so little solids as to be fitly included among the class of indifferent waters, are **Clifton**, in Gloucestershire, England, whose water con-

tains 4½ grains to 16 ozs., and is of a temperature of 74° Fahr.; **Mallow**, in Ireland, with water of 69°; **Malvern**, in Worcestershire, England, whose water is pure but cold, and used in painful affections of kidneys and bladder; and **Bristol**, with hot wells (80° Fahr.), whose water contains 5¾ grains to 16 ozs., chiefly sulphate of lime and soda, and over 3 cubic inches of carbonic acid gas.

II. Common Salt Waters (Muriated Saline Waters—Sool Waters).

The waters to be considered under this head are those whose chief constituent is common salt, chloride of sodium, a compound of chlorine with sodium. Similar compounds with potassium, magnesium, and calcium (lime) also occur, the chlorides of potassium, magnesia and lime, but it is the sodium salt that is the most important. Waters rich chiefly in this ingredient are used both for bathing and for drinking purposes. Baths containing this ingredient are in Germany called **sool-baths** (sool-bäder). The chief effect upon the skin is a stimulating one, much more stimulating than simple water. It is for this purpose that sea-bathing is employed in the case of scrofulous children, and others with defective nutrition. The strong stimulating effect upon the skin not only exerts a bracing and tonic effect upon it by improving the circulation in it, but has a secondary effect upon all the functions of the body, quickening their activity and promoting tissue change. The pronounced effect of the addition of salt to water is shown by the fact that a bath which contains salt will have as strongly stimulating an effect upon the skin as much hotter water containing no salt in solution. Waters too rich in this ingredient may stimulate to an excessive degree leading to irritation. The exact degree of stimulation is determined by the quantity of salt in solution, the duration of the bath and its temperature. It appears that 2 to 3 per cent of salt is sufficient, that is 150 to 300 grains of salt in 16 ozs. of water, and that 10 per cent is too strong, and that a salt bath of 95° Fahr. will be as stimulating as one of plain water at 100°·8. When the natural water of the spring is too strong it is diluted, and when too weak it is strengthened by the addition of concentrated waters. When such waters are taken internally they stimulate the walls of the stomach and bowels, and if excess be taken the stimulation passes into irritation, evidenced by vomiting and perhaps purging, and other signs of catarrh of the stomach and bowels. But the waters have far wider effects than these. It must not be forgotten that salt exists in every organ and tissue of the body, and in every fluid and secretion or excretion (see pp. 535 and 541). About 3000 grains are present altogether in the body, 300 of them being ever in a state of coming and going, being expelled from the body with urine, sweat, &c., and being restored with food. Salt appears to have a very powerful influence in promoting the digestion and absorption of certain foods, and in the blood and tissues its presence seems to promote the activity of tissue change. At any-rate an increase in the quantity of salt introduced is soon followed by an increase in the amount of urea expelled, the result of the change albuminous food-stuffs undergo in the body (see p. 539). In a case where no common salt is introduced, it yet continues for a long time to appear in the urine, as if change could not go on without it, and the tissues could store up an extra quantity in case of need. Again, the absence of salt from the food or its presence in deficient quantity leads to serious disturbances of general health. A very important part in nutrition is also played by the chloride of potassium. By experiments with animals it has been shown that the absence of the latter from food, though the former be present in abundance, will be evidenced by feebleness and emaciation of the animal.

These facts are partly explanatory of the circumstance that the drinking, in appropriate quantity, of salt waters will greatly improve the nutrition of the body by its stimulating effects on tissue change. Thus such waters are used for this purpose in gout and scrofula. They are often effective in bloodlessness in women, when iron treatment has failed, and they also aid the absorption of iron. In general ill-health, the result of exposure to malaria, they have often proved useful, and in retarded convalescence from acute disease. Their stimulating effects upon the secretions of stomach and liver and other digestive organs are the cause of their extensive use in dyspepsia, both acute and chronic. For this purpose they should be taken cold, and in such quantity that from 60 to 300 grains of salt are introduced in this way daily. The carbonic acid gas they contain assists in producing the effect. In sluggishness of liver and bowels their employment is attended with benefit, as well as in other congestive disorders of other organs, such as the womb. Some of these waters are famous in the treatment of diseases peculiar to women, notably Kreuznach, and in England Woodhall. In both these waters

II. COMMON SALT WATERS (MURIATED SALINE WATERS).

Name.	Situation.	Altitude in Feet.	Quantity of Common Salt in grains in 16 ounces.	Quantity of Carbonic Acid Gas in cubic inches in 16 ounces.	Temperature of the Water in Degrees Fahr.	Remarks.
Adelheidsquelle	See Heilbrunn					
Baden-Baden	Black Forest	616	14½	1½	114·8 to 154·5	Contains also 2 grs. lime and traces of arsenic and bromine. Season, May to October.
Bex	Vaud (Switzerland)	1400				Grape-cure establishment.
Bourbonne-les-Bains	France (Vosges)	900	46	18	115 to 147	6 grains lime sulphate.
Canstatt	Würtemberg	600	16 to 19	19 to 27	63·5 to 69·1	Contains also ¼ gr. carbonate of iron, and 14 grs. lime salts. 4 miles from Stuttgart. Mud-baths and whey establishment.
Cheltenham	England		74·5		Cold	
Cronthal	Germany (nr. the Taunus)	500	22 to 27	33 to 40	56·7 to 61·2	Contains also 5 grs. lime salts and a trace of iron.
Dipso or Aedepsos	Greece (Negroponte)		68	2	88 to 162	Also ½ cub. in. sulphuretted hydrogen, 7 grs. of Epsom and Glauber's salts and iodide and bromides.
Droitwich	England,		2·500		Cold	
Dürkheim	Bavaria (foot of Haardt Mountain)	358	71 to 79	4 to 5	Cold	Grape and whey cure establishments. Contains 15 grs. lime salts and ¼ gr. iron, and iodine and bromine compounds from $\frac{1}{10}$th to $\frac{3}{10}$th grain.
Hall	Tyrol	1700	112	2	Cold	Contains iodine and bromine compounds to nearly 1 grain and a minute quantity of iron. Great repute in scrofulous goitre. Season, May to October.
Heilbrunn (Adelheid Spring)	Bavaria	2400	38	13	Cold	Contains nearly 1 gr. iodine and bromine compounds, and $\frac{7}{100}$th iron, and 6 grs. carbonate of soda.
Homburg (Elizabeth Spring)	Central Germany (Taunus)	600	48 to 104	43 to 109	50	Contains 17 grs. lime salts, ⅛th gr. iron. Season, May to September.
Ischia	Island, 20 m. from Naples					Season, spring and summer. Whey-cure.
Ischl	Austria	1400	223			Whey establishment and mud-baths. Season, May to September.
Iwonicz	Galicia		47 to 60	30	Cold	Contains also 8–13 grs. carbonate of soda, and small quantities iodine and bromine. Used as the waters of Kissingen.
Kissingen (Rakoczy Spring)	Bavaria.	590	17½ to 44½	41	Cold	Season, May to September.
Kreuth	Between Munich and Salzburg	2911				Salt springs used for baths for irritable and scrofulous subjects. Sheltered situation and still atmosphere. Whey-cure establishment.
Kreuznach	Rhen. Prus.	286	57 to 108	0	Cold	Season, end of April to beginning of Oct.
Leamington	England		40 to 60	2 to 3	Cold	Contains also from 32 to 40 grs. Glauber's salt, 20 chloride of lime, and small quantities of iron, bromine and iodine. (See table, p. 934.)
Mergentheim	Würtemberg	590	51	13	Cold	Contains small quantities iron, 15 grs. Epsom and 21 Glauber's salts, and 10 grs. sulphate and carbonate of lime.
Mondorf	Luxembourg	600	67	1	77	Contains 12 grs. indigestible sulphate of lime, and 24 of chloride, and ·002 arseniate of soda.
Nauheim	Hesse-Darmstadt	450	109	15	72	Contains 11½ grs. bicarbonate of lime, and ·2 carbonate of iron, ·004 arsenic, ·3 bromide of magnesium, and 8 chloride of lime. Other stronger springs used for bathing.
Neuhaus	nr. Kissingen	700	76	33		
Pyrmont (Salt Spring)	Waldeck	404	54	23	Cold	Contains also sulphate of magnesia 7 grs., sulphate and carbonate of lime 16 grs. (For iron springs at Pyrmont, see Table VIII.) This spring is suited for drinking.
Rehme Oeynhausen	Westphalia (betw. Minden and Cologne)	134	240	18	80 to 93	Very fine modern baths, gas baths, &c. Waters too strong for drinking. 22 grains lime sulphate.
Reichenhall	Bavaria	1407	23 per cent		57	Strongest salt spring in Europe used for bathing. For drinking 1 to 1½ oz. in glass of water. Whey establishment. Has an inhaling chamber, air impregnated with salt spray, useful in catarrh of chest and stomach. 32 grains lime sulphate.
Saratoga (Empire Spring)	U.S.A.		50½	34½	Cold	
Schmalkalden	Hesse	1000	71	8	Cold	Contains also 22 grs. lime sulphate, making it less suitable for drinking. Mud and pine baths.
Soden	Nassau (Taunus)	446	18 to 117	30 to 48	Lukewarm	Whey cure.
Soden	Near Aschaffenberg	440	40	0	Cold	The spring for bathing contains 160 grs. salt in 16 ounces.
Thermia (Island)	Greece		51½	3	116	Contain also bromine and iodine and 9 grs. Epsom salt.
Wiesbaden	Nassau	323	52½	6½	156	
Wildegg	Switzerland	1100	75			13½ grains sulphate of lime make it indigestible.
Woodhall	Lincolnshire, England		120			Contains ½ gr. bromide and ¼ gr. iodide of sodium.

there is present a small quantity of iodine or bromine or both, and to it the curative effects have been attributed. It is generally believed, however, that the undoubted benefits of such waters in inflammatory and congestive conditions of the uterine organs are the result of the stimulating effects of the salt water and not of the minute quantities of the other ingredients, and we shall, therefore, include them in the present group. By virtue of their stimulating tissue change they aid in removing enlargements from joints and from other parts of the body where inflammation has been accompanied by thickening of parts. The baths are most valuable aids to the waters in cases of weakness of the skin and convalescence from disease. Care must always be taken that excess is not drunk and dyspeptic symptoms set up by this means.

Baden-Baden (616 feet) is situated in the Grand-duchy of Baden, Germany, in a beautiful valley of the Black Forest, easily reached from Frankfort or Strasburg. It is a most popular pleasure resort, with a warm climate, the mean annual temperature being 48°, sheltered by its situation, and with abundant accommodation for visitors, of whom there are more than 4000 annually. Four of its chief springs have been united by shafts, executed under the government of the duchy. The baths are the chief means of treatment employed, but the waters, from their small amount of solid constituents, a total of 22 grains in 16 ounces, are suitable also for drinking. This is at the same time a small quantity for bath purposes, producing little more effect than the simple waters. Slight forms of gout, rheumatism, and scrofula, catarrh of stomach, and congestion of abdominal organs are benefited by Baden-Baden, while persons merely requiring change of air and relaxation without having anything specially wrong with them could not, according to Dr. Macpherson, go to a better place. Two of the springs, the Murquelle and the Fettquelle, contain appreciable quantities of lithia, and arsenic is also present, but whether they have any effect on the body is not known. The season is from 1st May to 31st October, but is at its height from the end of August to the middle of October.

Bourbonne-les-Bains (900 feet), the French Wiesbaden, is in the department of the Haute-Marne, near the station Laferté, on the Paris-Muhlhausen line. Besides the common salt and carbonic acid, as indicated in Table II., the waters contain 14 grains (to 16 ozs.) of lime salts, and a third of a grain of bromide of sodium. It is one of the stronger saline springs, suitable for such cases as have been noted in the general description of the uses of salt springs. Ague, tumours of the spleen due to malaria, and cases of torpid liver are especially the cases for Bourbonne. Two pints is the quantity of water usually drunk, in association with the baths.

Cheltenham, in the west of England, is mentioned in this group because of one spring, in which the chief ingredient is common salt, though it also contains 11¾ grains of Glauber's salt (sulphate of soda), entitling it to be placed among the bitter waters (p. 934).

Droitwich water has a very large quantity of saline ingredients, 39 grains of Glauber's salt and 38 sulphate of lime, besides the common salt mentioned in the table. It is used only for bathing in chronic rheumatic and gouty conditions, chronic skin eruptions, in lumbago and sciatica, and as a stimulant for the removal of thickenings. The waters are used diluted for the baths at a temperature between 95° and 112°.

Homburg is one of the most popular and one of the most English bathing resorts of Europe. It is a town of 8000 inhabitants, situated on an elevated ridge, and is amply provided with parks, gardens, and shady walks. Its visitors number over 11,000 annually. It is reached by railway from Frankfort-on-the-Main in half an hour. Its waters are used for bathing, for which they are heated, and for drinking. It has five springs, Elizabethenbrunnen, Luisenbrunnen, Kaiserbrunnen, Ludwigsbrunnen, and Stahlbrunnen. The first is chiefly used, and its composition in detail is as follows according to Fresenius:—

Common Salt (Chloride of Sodium),	75·7	grains	in 16
Chloride of Potassium,	2·6	,,	,,
Chloride of Calcium,	5·28	,,	,,
Chloride of Magnesium,	5·6	,,	,,
Sulphate of Lime,	0·1	,,	,,
Carbonate of Lime,	11·6	,,	,,
Carbonate of Magnesia,	0·2	,,	,,
Carbonate of Iron,	0·18	,,	,,
Carbonic Acid,	45 cubic inches.		
Temperature,	50° Fahr.		

The last-named spring—Stahl—is more strongly iron than the others; while the Ludwigsbrunnen is the weakest and pleasantest drinking water. The Elizabeth spring has an opening effect on the bowels after three glasses, and the waters are employed in congestions of abdominal organs, and are specially useful in gout, rheumatism, and dyspepsia, and to those indisposed after a winter's round of gaieties, and to the overworked

professional or business man. The more pronounced iron springs are suitable in persons debilitated by Indian heat. The bathing accommodation has of late been greatly increased; and the Kaiserbrunnen is chiefly used for the baths.

Ischia, a volcanic island at the northern corner of the Bay of Naples, has no less than 14 springs all more or less warm, the chief, Gurgitello, having a temperature of 158° F., and containing 135 grains of solids in 16 ounces, chiefly salt and carbonate of soda, charged also with carbonic acid gas. They are used in gout, rheumatism, paralysis, scrofula, skin diseases.

Ischl (1400 feet) lies in the valley of the Traun in Austria, in the Salzburg district, the nearest station being Gmunden. Its high situation and hilly surroundings confer upon it a mild equable climate, and it is specially sought in chest affections. There is excellent accommodation, a well managed hotel, and a hydropathic establishment. The waters are used for bathing, being diluted for the purpose.

Kissingen lies in the valley of the Saale, North Bavaria, six hours' railway journey from Frankfort. It is a popular resort, the visitors numbering over 13,000 annually, and there is abundant accommodation suitable for various lengths of purse. The surroundings are both interesting and beautiful. It has numerous springs, typical of the salt springs we are considering. Three of them are used for drinking, Rakoczy, Pandur, and Maxbrunnen, and others for bathing, Soolsprudel in particular. The composition of Rakoczy and Maxbrunnen in detail is as follows:—

	Ingredients in grs. per 16 ozs. Rakoczy.	Max-brunnen.
Chloride of Sodium (Common Salt),	40·75[1]	17·52[2]
Chloride of Potassium,	2·00	1·14
Chloride of Magnesium,	2·12	·51
Chloride of Lithium,	·14	·004
Sulphate of Magnesium,	4·11	·00
Sulphate of Lime,	2·72	1·06
Carbonate of Magnesium,	·11	·00
Carbonate of Iron,	·22	·00
Carbonate of Lime,	7·42	4·62
Phosphate of Lime,	·04	·03
Silica,	·09	·07
Nitrate of Sodium,	·06	·65
Bromide of Sodium,	·05	·00
Carbonic Acid Gas,	41 cub. in.	41 cub. in.

These tables exhibit the composition of the stronger and of the weaker drinking water. The former is generally taken in the morning to the extent of three to six glasses. The Pandurbrunnen resembles Rakoczy, but contains more gas. The small quantity of sulphate of lime is noticeable and advantageous, because it is not absorbed. The water of Maxbrunnen is used as an ordinary table water. The waters of Kissingen are suitable for all cases for which salt waters are employed (see p. 928). The Soolsprudel, used for bathing, contains 2 per cent of salt, and 30½ cubic inches of gas to 16 ozs., and when the water is heated the amount of gas given off is so great that giddiness and difficulty of breathing are commonly experienced, because of its inhalation.

[1] Tichborne's analysis, 1883. [2] Liebig's analysis.

Kreuznach lies in the valley of the Nahe within an hour by rail of Bingen on the Rhine. Its climate is mild in early spring and late autumn, but hot in summer. It has a high reputation for the treatment of scrofula, more patients of that kind being found here than at any other spring, as well as for affections of the womb. Its effects were believed to be due to the iodine and bromine in the water, but are, according to Braun, rather to be attributed to the drinkable character of the springs, the climatic conditions, the agreeableness of the place, and the well adapted method of treatment. "Kreuznach is a typical model as regards the mode of treatment and the internal and external application of Sool-springs." The chief spring used for drinking is the Elisenquelle, which has the following composition in grains per 16 ozs.:—

Common Salt,	72·88
Chloride of Lime,	13·39
Chloride of Magnesium,	4·07
Chloride of Potassium,	·62
Chloride of Lithium,	·61
Bromide of Magnesium,	·27
Iodide of Magnesium,	·03
Carbonate of Lime,	1·69
Carbonate of Magnesium,	·10
Carbonate of Iron,	·15
Silica,	·13

Of this water 4 ozs. are usually drunk to begin with, and the dose increased to 20 or even 30 ozs. There are several other springs, Oranienquelle, Carlshalle, Theodorshalle, and Münster-am-Stein, of which the first contains 108 grains of salt in 16 ozs., and the last only 60. In association with the drinking water, baths are systematically used, taken about an hour after drinking, at a temperature of about 90° to 92°. At first the bath lasts for a quarter of an hour, but is increased to three-quarters; and the water for the bath is strengthened by the addition of "mother-lye." To this combination of strong salt baths with the weaker drinking water Braun attributes much of the beneficial effects produced. The quantities of iodine and

bromine are too small to be credited with them. The cases for which Kreuznach has greatest repute are those of scrofulous swellings, the stimulation of the salt baths and the action of the water in promoting tissue change leading to their absorption. The water also increases the secretion from the bowels. In congestion, chronic inflammation, and thickening of the womb and other abdominal organs, in similar affections of the breasts, and in cases of painful monthly illness connected with similar conditions, they are most valuable, as well as in the other diseases indicated in the early paragraphs on salt waters.

Soden, a town of 1500 inhabitants, lies at the foot of the Taunus range, and is half an hour's journey by rail from Frankfort. It has a warm equable climate, somewhat moist, and has long been much resorted to in conditions of chronic catarrh of the lungs, consumption, and disorders of the abdominal organs. Spring, late summer, and autumn are the best times for a visit, as the heat, owing to its sheltered situation, is often oppressive in summer. About 1300 feet higher on the slope of the mountains is **Falkenstein**, which is much more bracing, though well sheltered from the north and east, and more suited for chest diseases. Soden has no less than twenty-three springs with varying quantities of common salt, but none of them with sufficient to make them very stimulating. Some of the wells contain ·2 to ·3 grain iron.

Wiesbaden, a town of 50,000 inhabitants, is the capital of Nassau, five miles north-west of Mayence, and has annually upwards of 60,000 visitors, to whom it offers all variety of accommodation. It lies in a valley exposed to the south only. Its winter climate is not severe, and in summer it is intensely hot, so that early spring or late autumn is a very suitable season. Many of the hotels have baths supplied direct from the springs, of which there are seventeen, from which the water issues warm. The water is abundant, and all is used for bathing, but only one source, Kochbrunnen, is used for drinking. The quantity of solids dissolved is so little comparatively, that the baths have the effect of little more than simple warm waters, though they are not to be used in irritable skin eruptions and eczema. They are useful for gout, rheumatism, and paralysis. Wiesbaden is " one of the most beautiful, amusing, and effective baths, rivalled but by few in its ability to satisfy all requirements, both the simplest and the most complicated, and in the excellent arrangements for the use of its waters."

The composition of the water is as follows, in grains per 16 ozs.:—

Common Salt,	52·49
Chloride of Potassium,	1·19
Chloride of Ammonium,	9·12
Chloride of Lime,	3·61
Chloride of Magnesium,	1·56
Chloride of Lithium,	·001
Sulphate of Lime,	·69
Carbonate of Lime,	3·21
Carbonate of Iron,	·04
Arseniate of Lime,	·001
Bromide of Magnesium,	·027
Carbonic Acid,	6½ cub. in.
Temperature,	156° Fahr.

It is pointed out that the drinking of such water as the above in a warm condition, and with its small amount of gas, results in the water being absorbed and passing through the body, promoting tissue change. Whereas a cold water with the same quantity of salt and more gas would stimulate stomach and bowels, producing increased activity of the bowel. All the diseases indicated on p. 928 are treated by the Wiesbaden water, and specially gout and rheumatism.

Woodhall, near Horncastle in Lincolnshire, England, has of recent years come much into repute for the treatment of rheumatism, scrofula, and uterine complaints. Its value is ascribed to the iodine and bromine it contains, and it is called the "Iodine Spa." Braun, however, believes the effects to be due to the common salt and other conditions. A recent analysis of Professor J. A. Wanklyn indicates also the presence of *free* iodine, an observation of importance, as a very minute dose of *free* iodine would yet have marked effects, and it may be that the undoubtedly beneficial influence of the water is due, to some extent, to this ingredient. The analysis in 16 ounces is as follows:—

Common Salt,	133	grains.
Chloride of Lime,	11·1	,,
Chloride of Magnesium,	9·1	,,
Carbonate of Soda,	1·0	,,
Sulphate of Soda,	·03	,,
Nitrate of Soda,	·05	,,
Free Iodine,	·02	,,
Iodine as Iodates,	·02	,,
Iodine as Iodides,	·04	,,
Bromine as Bromides,	·34	,,
Iron,	traces.	

Much has been done by the building of a well-equipped bathing-house, hotel, &c., to make the place pleasant for visitors, and in Woodhall there now exists for English invalids a rival to Kreuznach.

In America there are the **Saratoga Springs**,

of which the Empire Spring has 50½ grs. salt in 16 ozs., with 16 grs. bicarbonates of magnesia, soda, and lime, ·07 iron, traces of sodium and bromine, and 34½ cub. in. of carbonic acid gas.

Bad-Nauheim, in Hesse-Darmstadt, has of late years sprung into prominence because of the value of its waters in the treatment of chronic heart affections. The observations of the late Dr. August Schott, and the writings of his successor and brother, Dr. Theodor Schott, have made the place famous for these conditions, and the system of treatment initiated by them is called **"The Schott Treatment of Chronic Heart Affection"**.

Bad-Nauheim is a little town of barely 4000 inhabitants, nestling at the foot of a spur of the eastern slope of the Tannus Mountains. It is on the main line of the Hamburg-Hanover-Cassel-Frankfort railway, a run of about forty minutes from Frankfort. It is a nine hours' journey by express train from Hamburg; and there is through service from the Hook of Holland through Rotterdam and Cologne to Frankfort, from Flushing through Cologne, and from Calais through Brussels and Cologne, the through journey from London taking about nineteen hours. It lies at an elevation of about 450 feet above the level of the sea, and the atmosphere is dry though not exactly bracing. Homburg is distant fifteen miles across country. The Spa belongs to the Grand Duchy of Hesse-Darmstadt, and the administration has done much for the visitors who now throng to it in thousands annually. It has the usual attractions of a handsome Kur-haus, well laid-out park, and daily band performances during the season, which begins about the middle of May and lasts till October. It possesses in all six springs, two of which are used for baths, and four for drinking purposes. The baths, however, are the chief agents in treatment, much less importance being attached to drinking the waters.

The chief saline ingredients of the bathing water are common salt and chloride of calcium; the waters are exceptionally rich in carbonic acid gas; and the temperature is only a few degrees below blood-heat, between 89° and 96° Fahrenheit. One spring is named Friedrich-Wilhelm's (or No. 12), and the other "Great Sprudel" (or No. 7), and the principal details of their composition are given in the following column. It will be noticed from the analysis that No. 12 is richer in common salt, containing about 3 per cent, richer in chloride of calcium, contains less carbonic acid gas, and is of higher temperature than No. 7, but the

	Spring No. 12. (percentages.)	Spring No. 7. (percentages.)
Common Salt,..................	2·929	2·182
Chloride of Calcium,.........	·232	·170
Chloride of Potassium,......	·111	·049
Chloride of Magnesium,....	·052	·044
Bicarbonate of Lime,.......	·260	·235
Free Carbonic Acid Gas,...	·197	·237
Temperature,..................	95·54° Fahr.	88·88° Fahr.

There are also small quantities of bromide, iodides, iron, arsenic, &c.

higher temperature causes the gas to come off more rapidly. Each of these springs discharges through a pipe, opening freely into the air, and carried a considerable distance vertically into the air. Round each pipe is built a reservoir, and the water escaping from the pipe, falls back into the reservoir. The reservoirs are quite open to the atmosphere; much of the carbonic acid gas, therefore, escapes, and with the escape of the gas certain salts of iron it helped to keep in solution, are precipitated out, and the water, which, as it comes from the spring, is perfectly transparent, becomes of a muddy, rusty colour. The quantity of gas dissolved in the water is so great that it drives the water out of the pipe with great force, so that it springs into the air to a distance of 40 or 50 feet, in much the same way that, were the cork removed, a soda-water bottle would drive its contents into the air. These tall, straight columns of foaming water, constantly rising into the air day and night from year's end to year's end, are a very remarkable spectacle. The reservoirs are built in the park, and in the immediate neighbourhood are the bath-houses, six in number, capable of accommodating at one time between 200 and 300 bathers.

Broadly speaking, there are three kinds of baths in use at Nauheim. I. The mildest bath is of water drawn from the reservoir, which has lost, therefore, much of its gas, which may have its temperature raised or lowered by the addition of hot water or ice, and which may be varied in strength by the addition of "mother-lye". (There are salt works in Nauheim, in which the unused water is concentrated and from which the common salt is removed, the remaining liquid is the mother lye, and this evaporated down yields bath-salt, rich in chloride of calcium, and used for making artificial baths.) II. The second kind of bath consists of water carried directly from the spring to the bath tub by a branch pipe, without previous exposure to the air. It contains the normal quantity of gas; and the water foams and bubbles as it enters the bath-tub. This bath is highly effervescent and is a peculiarity of Nauheim.

III. In the third kind of bath, the water is not turned off when the tub is full, but an overflow pipe is opened, and the patient lies in the bath while the foaming water streams through it. This is called a current-bath (strom-bad). Each of these three varieties of baths may be given with water from either of the two springs, and the springs may be mixed in the one tub, so that a great variety of bath may be given, according to the requirements of the patient.

The baths are used for a great variety of disorders—rheumatism, in its manifold forms, gout, disorders of the heart and circulation, nervous diseases and diseases of women, chronic inflammatory affections and the thickenings that accompany them. But it is for the treatment of heart affections that the waters have become famous. The saline ingredients of the waters stimulate the skin, and the carbonic acid gas forming in fine bubbles on the surface of the body, and constantly escaping from it to be replaced by fresh bubbles, maintains and accentuates this effect on the blood-vessels and nerves of the skin. A patient entering the bath, which is a few degrees below the temperature of the body, feels the water somewhat cold, and there is often a sense of oppression and constriction of the chest. This feeling lasts only a moment, and then a delightful sensation of warmth and comfort steals over him because of the action of the water on the blood-vessels of the skin. The blood is brought to the surface, so that after even 20 minutes' immersion the patient comes out of the bath warm and comfortable, the skin universally pink. The blood being thus brought to the surface, congestions of deep organs are relieved, and the absorption of inflammatory products promoted, while the action of the minute bubbles of gas on the terminal nerves of the skin acts reflexly on the nervous system, and through it on the heart, whose action is strengthened, slowed, and regulated. It is, therefore, weak and dilated conditions of the heart that are suited, *par excellence*, for this treatment, though all forms of heart disease benefit.

The "Schott Treatment" combines the uses of the baths with a system of muscular exercises with resistance, to give which there are in Nauheim men and women specially trained. The exercises consist of movements of flexion and extension of the limbs and of the trunk. For instance, the patient extends both arms straight in front of him, palms against one another. From this position he moves the arms outwards from the middle line till they are straight out from the side and in line with the shoulder. This is done very slowly, and without jerk, the patient breathing quietly and steadily all the time. The operator, standing in front of the patient, places the palms of his hands on the outside of the patient's wrists, and gently resists the movement. The operator holds the patient's arms in this position for a moment, and then the patient brings the arms forward again to the middle line, the operator resisting. The art of the operator consists in getting the patient to perform the movements quite slowly and steadily, without holding the breath, and in adjusting the resistance, which is never great, to suit the patient. To perform another of the movements the patient lets his arm hang down straight at his side, and then slowly bends the forearm on the upper arm, and straightens it again, the operator resisting meanwhile. Between each movement the patient is made to rest a few seconds. The exercises are given to the patient standing, by preference, but the patient may be seated, or even lying down. There are some half-dozen such movements for the arms, several for the legs, and others for the trunk, all of them being resisted in a particular way, and to a carefully regulated degree, by the operator. The effect of these movements, when properly adjusted to the individual case, in strengthening and slowing a weak and irritable heart can be watched by observing the pulse.

To this treatment may be added that of graduated hill exercise (terrain-kur), somewhat after the system of Oertel, of Munich. A variety of other remedial agents, common to many spas, may also be brought into operation at Nauheim, such as the whey cure, grape cure, &c.

By the use of common salt and chloride of calcium (or the Nauheim bath-salt), with acid and soda to produce effervescence, an artificial Nauheim water can be prepared anywhere, and the Schott system of treatment followed away from Nauheim. Such artificial Nauheim baths are now made use of in Bath in England and in Buxton, and may be employed by any physician anywhere.

As a result of his observations during portions of two seasons spent at Nauheim, and of the use in private practice of the artificial baths in a large number of cases, the author is convinced that no other form of treatment offers so great prospects of benefit in many disorders of the heart in which the routine treatment by rest and heart tonics has proved unsatisfactory or of merely temporary benefit.

Waters of kindred properties to those of Nauheim are to be found in Rehme-Oeynhausen, in Westphalia, and in Bourbon-Lancy in the department of Saone-et-Loire, France.

III. Bitter Waters—Aperient Waters—Sulphated Waters.

The chief ingredients of these waters are sulphate of magnesia, commonly called Epsom salts, from the once popular well at Epsom of which it was the principal constituent, and sulphate of soda or Glauber's salt, because it was first discovered and described by Glauber in 1658. The action of these salts has been sufficiently described on pp. 862 and 863. They produce, when given in sufficient doses, a profuse watery secretion from the bowels; indeed, in large doses they produce a catarrh of the bowel, and consequently their frequent use in *large* quantities is not desirable. A glance at the table will show that many of these mineral waters contain little of importance beyond the sulphates of magnesia and soda, while others contain, besides fair quantities of common salt, carbonate of soda and carbonic acid gas. The addition of these other ingredients is of considerable significance. A water which contains them will have with less of the sulphates an opening effect equal to one richer in the sulphates but without these additional constituents. Even carbonic acid gas alone, in addition to the Epsom and Glauber's salts, is a great advantage because of its tonic effect on the mucous membrane, so that a weak aerated bitter water will be of equal value with a strong non-aerated bitter water, so far as its aperient effect is concerned, and will be less likely to occasion disturbance. The same thing is true of the common salt and the carbonate of soda. Some of these waters contain iron besides the other constituents named, notably Marienbad, Carlsbad, Franzensbad, and Tarasp. One may, therefore, perceive how much more beneficial such natural and complicated waters are than a simple draught of Epsom or Glauber's salts artificially prepared. Further, Glauber's salts are milder in action than Epsom, and waters containing them rather than the latter are preferred, Carlsbad for example. Of the simple aperient waters, Püllna, Saidschütz, Sedlitz, Birmensdorf, Hunyadi Janos, and Friedrichshall are the chief; and of those which contain also carbonate of soda, as well as common salt, Carlsbad, Marienbad, Tarasp, Franzensbad, Elster, and Bertrich are the principal. Aesculap, lately introduced in bottled condition, belongs to the latter class, and so also does Mattoni's Royal Hungarian Bitter Water.

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The chief use of these waters is in sluggish conditions of abdominal organs, in constipation, in congestion and enlargement of the liver, in piles dependent upon such states of the liver, in gall-stones, and in enlarged spleen. They are specially beneficial for persons of a too full habit of body, specially when such a condition is largely due to excess in diet and deficient exercise. The action of the waters on the bowels stimulates tissue change, and is a direct incitement to the removal of deposited fat, so that such persons lose some of their superfluous bulk, while they do not become weakened or less vigorous muscularly, under a judiciously directed course of the waters. In indigestion consequent upon sluggish circulation in the bowels, they are also useful. In some cases of gout, also, they are valuable, as may readily be understood from what has been said, and also in gravel. Some of them, specially those rich in carbonate of soda, such as Carlsbad, are made use of in diabetes with some benefit.

Aesculap is obtained from springs at Buda-Pest, in Hungary, and is bottled for use. It is an excellent aperient in doses of a wine-glassful to a tumblerful, with an equal quantity of hot water.

Carlsbad, in the Eger district of Bohemia, in a narrow valley, nearly 1200 feet above the sea-level, is a town of 12,000 inhabitants. The river Tepl runs through the valley, and the town is built on both sides. High and steep hills rise on either hand, the pine-clad slopes of which are rendered accessible by paths cut in all directions. The municipality has purchased 30,000 acres of pine-wood, which are laid out in mile upon mile of carefully-kept walks, and supplied at frequent intervals with seats for the sake of those pursuing the exercise-cure. A series of garden restaurants are set up, where visitors can breakfast or dine beneath the trees. Everything possible has been done by the municipality to attract and add to the comfort of visitors, even to the establishment of an official band, which, it is said, has few rivals in any great city. The number of visitors is 25,000 yearly. The springs are numerous, and differ little in their constituents, but vary in temperature and in the amount of dissolved gas. The chief is the Sprudel, situated in the centre of the town, over which has been erected a glass-domed building. It rises with a throbbing movement 4 or 5 feet in the air; falling back into an ornamental basin, round which stand

girls who fix the glasses of the visitors on to the end of long rods and dip them into the cauldron. The temperature of the water is 162° F., and a cloud of steam fills the building. Chief of the other springs are the Mühlbrunnen, the Schlossbrun, the Hygeiaquelle, and Theresien-

III. BITTER WATERS

(Sulphated Waters, Waters whose Chief Ingredients are Sulphate of Soda and Magnesia).

Name.	Situation.	Elevation above Sea-level in Feet.	Amounts of Chief Ingredients in Grains per 16 ozs.				CO_2* in Cubic Inches per 16 ozs.	Remarks.
			Sulphate of Magnesia (Epsom Salts).	Sulphate of Soda (Glauber's Salts).	Common Salt.	Carbonate of Soda.		
Aesculap	Hungary		175	134	30	14		⅓ gr. iron.
Bedford Springs	Pennsylvania (U.S.A.)		3·2	2·6				9 grs. sulphate of lime.
Bertrich	Near Coblentz	500	0	7	3	1½	4½	Warm spring.
Birmensdorf	Canton Zurich (Switz.)		169	54				
Carlsbad (Sprudel)	Bohemia	1,200	0	20	8½	14	12	Warm spring. Small quantity of iron.
Cheltenham (Pittville water)	England		0	11¾	48	2	1½	
Elster	Saxony	1,460		24	8	7	16	⅓ gr. iron.
Epsom			240					
Franzensbad (Franzensquelle)	Bohemia	1,569		25	9	8	40	Iron also.
Friedrichshall	Saxe-Meiningen	920	64·1	71·5	99·7	Carbonate of magnesia, 2·1	9	Chloride of magnesia, 50·1, 17 grs. lime sulphate (Tichborne).
Füred	Hungary			6	$\frac{7}{10}$	1	38	6 carbonate of lime and ·08 gr. iron.
Hunyadi Janos	Hungary	460	156	158	10½	5		Tichborne's analysis.
Leamington (Saline Spring)	England			28·7	68·8		1½	Season May to October.
Marienbad (Kreuzbrunnen)	Bohemia	1,980		32	10·1	11·4	15	$\frac{1}{10}$ gr. of iron.
Mattoni's Royal Hungarian Bitter Water	Hungary		122	101	20	13		·6 gr. iron and 10 lime sulphate.
Mergentheim	Würtemberg	591	16	22	51¼	Carbonate of lime and magnesia, 6·8	7½	10 grs. sulphate of lime, ·05 iron.
Ofen or Buda	Hungary	461	0	3	¾	2	5½	Warm 140° F.
Pullna	Bohemia		66·3	88	Chloride of magnesia, 12½	Carbonate of magnesia, 5½	2	2 to 6 grs. lime sulphate.
Purton	Wiltshire (England)		$\underbrace{\quad\quad}_{23}$		4·2	Carbonate of potash, 3½	6	10 grs. lime sulphate.
Rohitsch (Tempelbrunnen)	Styria	730		15½	$\frac{7}{10}$	6	25	Carbonate of lime and magnesia 21, iron ½ gr.
Rubinat	Pyrenees (Spain)		5	148½	3			Dose, ½ to 1 wineglassful.
Saidschütz	Bohemia	660	84	46	2	Carbonate of magnesia, 5	0	10 grs. of indigestible sulphate of lime.
Scarborough Wells	Yorkshire (England)		17 to 28		3½		0	
Sedlitz	Bohemia		104	0	3	3	0	8 grs. lime sulphate.
Stubuya	Hungary			4			3	Hot, 111° F.
Tarasp (Great Spring)	Lower Engadine (Switz.)	4,608		16½	29½	38½	33	⅕ gr. iron. See p. 796.
Victoria-Ofner	Buda-Pest		229½	120	12	8		16 grs. lime sulphate.

* CO_2 = Carbonic acid gas.

brunnen. The composition of the Sprudel is as follows, in grains per 16 ozs.:—

Sulphate of Soda,	19·8
,, Potash,	·4
Common Salt,	8·5
Carbonate of Soda,	14·2
,, Lime,	2·0
,, Magnesia,	·3
,, Iron,	·02
,, Lithia,	·08 (Tichborne).

The waters are drunk early in the morning before breakfast, from 2 up to 8 or 10 glasses of 6 to 8 ounces each being slowly imbibed, exercise in the open air being at the same time engaged in. This usually produces a slight opening effect. About an hour after the last glass a light breakfast is taken. Dinner is at 1 o'clock. A cup of coffee is allowed in the afternoon, a light supper at 8, and 9 o'clock is the recognized hour of retiring to bed. The diet is very carefully regulated by the physicians, the meals being very plain but well cooked. Meals may all be taken in the open air, and there is no such thing as *table-d'hôte*. The Carlsbad cure

is not only a water-cure, but also a diet-cure, an air-cure, an exercise-cure, and a rest-cure. The cases suited for Carlsbad are dyspeptic cases, cases of catarrh of stomach and chronic ulcers of the stomach and catarrh of bowels, of enlarged and fatty livers, of enlarged spleen, cases in which there is a tendency to gall-stones and biliary disorders, gout, and catarrhal conditions of the kidney and urinary organs. The lean dyspeptic ill-nourished man seeks Carlsbad to get rid of his dyspepsia and to put on fat, and the fat man seeks it to stimulate his tissue change and put off some of his fatness. Improvement is also observed here in many diabetic cases. The waters are also used for baths. The season begins in May, and August and September are found very pleasant months there. The bottled water should be used before breakfast and with exercise if possible, either 2 or 3 glasses warmed to 100° Fahr., with an hour's exercise before breakfast, or a milder course of half a tumblerful warmed, sufficient to secure a gentle motion. About 3,000,000 bottles of the water and 90,000 pounds of the salt are exported annually.

Cheltenham possesses several springs, one whose chief ingredient is common salt, mentioned in Table II., another, the Pitville spring, is placed in the present list of bitter waters. There are others which contain iodine and sulphur, and one strongly iron spring which will be noted later. Braun says concerning them that their chief defect is the small quantity of carbonate of soda and carbonic acid, but that this might be remedied by the addition of a certain quantity of Bilin or Fachingen or Vals water, and they might be heated to a suitable temperature. They are much used for liver affections in dyspeptic persons.

Elster (1460 feet), on the Bohemian frontier, between Plauen and Franzensbad, has a spring, besides the one whose analysis is given in the table (Albertsbrunnen), which contains 48 grains of sulphate of soda, 12 of common salt, 7 of bicarbonate of soda, and 25 cubic inches of gas. It is called the Saltzquelle. And there are others containing very little saline ingredients at all. Moor-baths are to be had here.

Franzensbad (1569 feet) is in the neighbourhood of the town of Eger, in Bohemia; and is a town of 2000 inhabitants. It has several cold springs, Salzquelle, Wiesenquelle, Sprudel, and Franzensquelle, of which the first and the last are the most used. They resemble Carlsbad in constitution, containing, however, more gas and sulphate of soda. They also contain minute quantities of iron. It is greatly resorted to by patients suffering from anæmia (bloodlessness), pale girls of this type, and others suffering from poverty of blood resulting from some acute disease or some exhausting illness. The treatment generally adopted here is milder than at Carlsbad, and well suited to excitable and weakly persons. It is a favourite resort of patients suffering from uterine diseases, while it is suited for cases of chronic dyspepsia, catarrh of the bowels, and derangements of the genito-urinary organs. Franzensbad lies on a moor, and the materials for moor, mud, or peat baths are thus at hand in abundance, and the baths themselves are to be had in perfection. Beneath the turf is a layer, many feet in thickness, of a soft black muddy substance. This is diluted with water from one of the springs, steam is passed into it, and it is thoroughly mixed up, and then all hard masses are carefully removed. A bath-tub is filled with this material at a temperature of about 80°, into which the bather steps and remains for about 20 minutes, after which a plunge into clean water removes all black material. Such baths are employed in gout and rheumatism, in some forms of paralysis, in nervous excitement, and over-sensitiveness of the skin. It soothes restlessness, dispels fidgety sensations, and tends to produce sleep. Besides at Franzensbad they are obtained at Carlsbad, Marienbad, Teplitz, Elster, Eilsen, Driburg, Nenndorf, Meinburg, Homburg, Kissingen, and other places.

Friedrichshall is not drunk at the source, but exported only. It is an excellent water for aperient purposes, and in smaller doses for stimulating tissue change in cases similar to those for which Carlsbad is suited. From a quarter to half a tumblerful should be taken in early morning with enough hot water to make it warm, as directed for Carlsbad. In biliary derangements, torpid liver, gout, gravel, specially in the full-blooded individual, it is particularly useful.

Hunyadi Janos is one of the most useful of aperient waters, taken in the morning to the extent of a claret glassful or thereby.

Leamington has several springs besides the one whose constituents are indicated in the table. One of them contains about a grain of iron in 16 ozs., and another is a sulphur spring. Of the aperient spring the defect is the absence of carbonate of soda, which might be remedied by the addition of some other water, such as Vichy. The waters are useful for all the conditions indicated in the paragraphs devoted to the consideration of bitter waters in general, the

accommodation is good, and the winter climate comparatively mild.

Marienbad (1980 feet) is twenty-five miles from Carlsbad, an hour's journey from Eger by rail. It lies in a broad valley surrounded by pine-clad hills. The springs resemble those of Carlsbad, but are stronger, are cold, and contain more carbonic acid gas. The chief wells are the Kreuzbrunnen and the Ferdinandsbrunnen. Tichborne's analysis of the former is as follows, in grains per 16 ozs.:—

Sulphate of Soda,	32·0
Bicarbonate of Soda,	11·4
Common Salt,	10·1
Carbonate of Lithia,	·08
Carbonate of Lime,	3·0
Carbonate of Magnesia,	2·0
Carbonate of Iron,	·1

These waters, being stronger than those of Carlsbad, are taken in smaller quantities. They are usually warmed. They are bottled for home use, and may be employed in substitution for Carlsbad and for similar conditions. Two-thirds of a tumblerful and one-third hot water may be taken as a morning dose, which should be sufficient to act on the bowels. A quantity of Marienbad water diluted with almost an equal bulk of hot water makes a draught as nearly resembling Carlsbad water as possible. Marienbad is not used for diabetic patients like its rival. It has 13,000 visitors annually.

Püllna water is a popular bottled water, stronger than Friedrichshall, but with similar action, so that less is necessary, a wine-glassful made warm with hot water being taken before breakfast. Tichborne finds the water to contain evidences of contamination of surface drainage.

Tarasp has already been noted as a health resort on p. 796. It has a cold spring, which is noteworthy for the large amount of antacids it contains. Besides the 38½ grains of bicarbonate of soda noted in the table, it contains 25 grains of bicarbonate of lime and magnesia, and about 3 grains of the indigestible lime sulphate.

Scarborough wells contain too much lime salts (13¾ grs. of sulphate of lime and 6 of carbonate) to be readily absorbed, and lie heavy on the stomach.

Kingswood, in Gloucestershire, is in possession of a bitter spring—the **Cherry Rocks** bitter water; **Beulah** spa, near Norwood, contains in 16 ozs. 61 grains of Epsom and 9 of Glauber's salts, and some common salt; **Streatham** well is another English bitter spring; and there are many others now forgotten.

Kissingen, from its small amount of Epsom salts (see p. 931), might also be ranked as a bitter spa, and **Uriage** also.

IV. Simple Soda Waters (Alkaline Waters).

These are waters whose chief ingredient is bicarbonate of soda. The actions of soda and potash salts have been considered in some detail on pp. 818, 819, 844, and 845. Briefly put soda and potash salts by their direct action (1) are capable of stimulating the flow of the digestive fluid of the stomach, of the bile, and of the pancreatic juice, and thus act as stimulants to digestion and to bile excretion. (2) They directly neutralize acidity of the stomach and bowels. (3) Passing into the blood they increase its alkalinity; and it has been pointed out that a lessening of the alkaline character of the blood is at least invariably associated with rheumatism, gout, and other diseases. (4) They also diminish the acidity of the urine, lessen its irritating character, and avert or diminish the tendency to the formation of certain forms of stone. Besides, in passing through the kidney, soda and potash increase the quantity of urine. (5) Moreover soda is excreted by the lungs, increasing the secretion of the bronchial tubes, and rendering expectoration more copious and free. (6) The directly soothing effect of solutions of soda upon the skin has been referred to on p. 845.

These facts and others of a like kind offer at least some sort of explanation of the circumstances which seem to indicate the use of soda waters to be beneficial. It is quite clear that many kinds of dyspeptic disturbances will be relieved by a course of soda waters, and indigestion is almost certain to be much relieved, and irritable conditions of stomach and bowels, such conditions as are indicated by a tendency to vomiting and diarrhœa. For catarrh of stomach and bowels they are valuable remedies, though when the catarrh is chronic, more stimulating waters, such as the common salt waters, are more likely to be permanently beneficial. The waters are also employed for biliary disorders, enlarged liver, and in cases of gall-stones. In other forms of catarrh, besides that of stomach and bowels, their usefulness is admitted, specially in that of the bronchial tubes, and of kidneys and bladder. In gout and gravel they are widely used, though the more complicated waters of Carlsbad, for example, are in most cases superior. This it would appear is due to the fact that the benefit results not from the mere increased alkalinity of the blood produced, but from the increased stimulus to tissue change

and the removal of fat. This soda waters accomplish, but not so satisfactorily as the more stimulating kinds belonging to Carlsbad, Marienbad, &c. Rheumatism is also treated with the alkaline waters, and diabetes is in suitable cases, mild cases in the early stages, frequently benefited. Diseases of women are also treated, but not those attended by poverty of blood, which rather demand iron waters. Indeed it is to be observed that soda waters have a lowering tendency. The prolonged use of even small doses impairs appetite and digestion, and depresses nutrition. The soda waters which also contain appreciable amounts of common salt are more

IV. SIMPLE SODA WATERS (ALKALINE WATERS).

Name.	Situation.	Elevation in feet.	Quantity of Soda in 16 ozs.	Quantity of Carbonic Acid Gas.	Remarks.
Apollinaris	A spring near Neuenahr, in Rhenish Prussia	225	9½ grains	47 cubic inches	Cold (62°·6 F.).
Bilin	Bohemia	645	26 ,,	33 ,,	Cold. Season May to September.
Desaignes (Eau de César)	Ardèche (France)		21½ ,,	21 grains	Cold.
Fachingen	Nassau, on the Lahn	337	28 ,,	33 ,,	Cold. ·11 gr. iron.
Fellathal	Illyria		25 ,,	38 ,,	Used for indigestion.
Geilnau	Nassau		8 ,,	23 cubic inches	·3 gr. of iron, 6 of magnesia and lime. Cold.
Gerolstein	Rhenish Prussia	1,200	5·7 ,,		4 grs. carbonate of lime and 3 of magnesia.
Gettysburg	U.S.A.		4·6 ,,		15·7 grs. carbonates of magnesia and lime, and 5·3 sulphate of lime.
Giesshübel	Bohemia		10 ,,	55 ,,	3½ grs. of lime and magnesia, ·3 of iron. Cold.
Kronenquelle	See p. 938.				
Mont Dore	France (Puy-de-Dôme)	3,300	4 to 5 ,,		Warm springs, 106° to 108° F. Contain also common salt
Neuenahr	Near Bonn, Prussia	276	6 to 10·8 grs.	12 to 47 cub. in.	Hot springs, 93°·2 to 104° F. Common salt 1 to 3½ grs., carbonate of magnesia and lime 3 to 7 grs., ·7 iron.
Preblau	Carniola		21 grains	66 cubic inches	Used for indigestion.
Salzbrunn	Silesia	1,270	18 ,,	38 ,,	Bicarbonate of lime and magnesia 7 grs., iron ·002, sulphate of soda 4·7. Whey establishment, moor-baths. Cold springs.
Saint Marco	Tuscany	See p. 938.			
Soulzmatt	In the Vosges	850	9 grains	9 cubic inches	7 grs. of carbonate of magnesia and lime.
Vals	Ardèche (France)	2,475	6½ to 40 grs.	14 to 30 cub. in.	Cold. Traces of arsenic and ·04 to ·2 gr. iron.
Vichy	Central France	787	24 to 30 grs.	12½ to 14 ,,	Springs 50° to 105° F. Contain also iron and arsenic.

stimulating, and therefore more generally useful. They are mentioned in the next table. It may be observed that the most of the soda waters contain a considerable quantity of carbonic acid gas, and perhaps its slightly stimulating properties may correct some of the depressing tendencies of the soda. In some skin affections alkaline baths are of much use. It will be noticed from the table that Mont Dore, Neuenahr, and Vichy are warm springs, the others are cold. The hot springs are resorted to when it is desired to produce effects after absorption of the waters into the blood, the heat aiding that absorption; the cold springs are chosen when a stimulating effect upon stomach and bowels is specially sought. In the cold springs the quantity of carbonic acid gas is naturally much greater than in the warm waters, and this increases their stimulating properties.

To the same class belong **Chaudes Aigues,** a hot spring (143° to 178°) in Cantal, between Clermont and Toulouse, used for rheumatism and enlarged joints, **Néris,** also a hot spring (114° to 125° F.), in the department of Allier, at an elevation of 800 feet, both feeble alkaline springs, **Evian-les-Bains,** near the Lake of Geneva, a weak spring, and **Teinach,** in Würtemberg, in the Black Forest, 1225 feet above the sea.

Apollinaris is much used as a table water. It is bottled at the spring, which rises in the valley of the Ahr, in Germany, near Neuenahr. Tichborne's analysis shows the constituents in grains per 16 ozs. as follows:—

Bicarbonate of Soda,	10·62
Common Salt,	5·
Sulphate of Soda,	2·4
,, Potash,	·14
Carbonate of Magnesia,	4·5
,, Lime,	2·88

It is useful in the conditions already indicated, chiefly gout, gravel, bronchial catarrh, tendency to gall-stones; and it is a very pleasant water for ordinary use from the quantity of gas it contains. The quantity of common salt, and Glauber's salt, though too small to classify the water as salt or bitter water, is yet a valuable constituent.

Bilin is in Bohemia, two hours from Teplitz.

Constituents in 16 ounces in grains.

Bicarbonate of Soda,	26·1
Carbonate of Lime,	2·75
,, Magnesia,	1·06
Bicarbonate of Lithia,	·05
Carbonate of Iron,	·1
Sulphate of Soda,	5·13
,, Potash,	1·75
Common Salt,	2·69

This is one of the strongest soda springs in Germany. It is used in similar circumstances to Vichy.

Mont Dore (3300 feet) is three or four hours' driving distance from the railway-station of Clermont-Ferrand, in the department of the Puy-de-Dôme, lying in the Dordogne valley of the Auvergne Mountains. It has six warm springs and one cold. Here there is an excellent bathing establishment, and all varieties of baths are much used in treatment. Inhalations are also given. The place is chiefly resorted to for lung affections, chronic bronchitis, and threatened phthisis, its elevation adding to its suitability for such cases. The season extends from the middle of June to the middle of September, but July is the best month. For cases of rheumatism it is also employed.

Neuenahr is situated in the valley of the Ahr not far from the Rhine, and between Bonn and Coblentz. It has four warm springs, none of them rich in solid ingredients, but all rich in carbonic acid gas, and one cold spring, rich in gas. The scenery in the neighbourhood is picturesque, the town is provided with public gardens and excellent bathing establishments, and the place has become much frequented. The waters are used for gout, rheumatism, scrofula, gravel, and catarrh, alike of digestive organs, bronchial tubes, and bladder. The small quantity of soda, 10·8 grains in the richest spring and only 6 in two of them, renders it questionable whether the benefit is greater than would be achieved by the use of indifferent waters.

Salzbrunn (1270 feet) is situated in Silesia, in a wooded valley, 43 miles distant by railway from Breslau. It has two springs used for bathing and two for drinking. They are cold, and while not very rich in saline ingredients, contain a good supply of gas. It has every advantage in the way of excellent establishments under medical supervision. Its high situation renders it specially serviceable in lung affections. A whey establishment is found, and mud-baths are to be had. The season is from May to October. Since 1880 another water has been introduced from Salzbrunn—Obersalzbrunn—the **Kronenquelle**, or Crown Spring water. The spring rises in the "Prussian Crown" hotel. Its composition is given as follows in grains per 16 ozs.:

Bicarbonate of Soda,	6·1
Bicarbonate of Lithia,	·08
Bicarbonate of Lime,	4·98
Bicarbonate of Magnesia,	2·83
Bicarbonate of Strontia,	·02
Carbonate of Iron,	·06
Common Salt,	·41
Sulphate of Soda,	1·26
Sulphate of Potash,	·28

The quantity of carbonic acid gas is 13½ per cent.

The water is specially recommended in cases of gravel and gout. It is imported in bottles, and may be used as Vichy or Vals.

Saint Marco water has been recently introduced for gravel, gout, rheumatism, and liver and kidney affections. It is sold in bottles, and is derived from a spring on the Marucheto estate in Tuscany. Its chief feature is the considerable quantity of lithia present. Each 16 ozs. contain—

9·116	grains	**Bicarbonate of Soda,**
11·395	,,	Bicarbonate of Magnesia,
1·869	,,	Carbonate of Lithia,
·701	,,	Bicarbonate of Lime,
4·663	,,	Common Salt,
4·567	,,	Sulphate of Soda,
2·155	,,	Sulphate of Potash.

Lozenges are prepared from salts of the spring.

Vals is situated in the Ardèche. The railway-station is Aubenas, from which it is 4 miles distant. It has several springs—Magdeleine, Précieuse, Désirée, Rigolette, and St. Jean. The last is the weakest and the first the strongest, Magdeleine containing 51 grains of bicarbonate of soda in 16 ozs. according to one analysis, and St. Jean only 10·3 according to the same chemist. The former and the spring Rigolette contain also nearly ·2 grain iron, and are used in the weaker classes of cases. At Vals there is also a spring—Dominique—which contains ·005 grain in 16 ozs., and is used in debilitated conditions and in intermittent fevers, and malarial affections of the spleen. Vals waters are, like those of Vichy, bottled under government supervision.

Vichy (787 feet) is situated on the Allier river, in an open valley at the foot of the Auvergne Mountains. It is south of Paris, a distance of about 7 hours' journey by fast train, and on a branch of the Paris and Lyons railway, and the springs, which are nine in number, are the property of the government, and are managed by the Compagnie Fermière de Vichy under the supervision of the government. The waters are drunk on the spot, are used for baths, and are bottled for export; while the Vichy salts, obtained by the evaporation of the waters, are manufactured into lozenges. The mineral establishments are conducted on a magnificent scale, the hotel accommodation is of great variety, and because of these and other circumstances Vichy is the most crowded spa in Europe. The season is from the middle of May to the middle of September, but July is unbearably hot. The daily flow of water from the springs is 113 gallons. In certain parts of the season the quantity required for baths, &c., exceeds this amount. So large vaulted cisterns, 12 feet deep, have been constructed in which the water is stored when less is being used, and from these vaults it is thought a water of more constant composition is obtained. The chief springs are Grande-Grille, Hôpital, Hauterive, Mesdames, Celestins, Parc, Grand-Puits Carré, and Petit-Puits. The last two are chiefly used for baths. The composition of five of these springs is given by Tichborne from a recent analysis as follows, in grains per 16 ozs.:—

	Grande-Grille.	Mesdames.	Hôpital.	Parc.	Hauterive.
Bicarbonate of Soda,	29·48	24·03	31·42	29·8	30·
Bicarbonate of Potash,	2·16	1·12	·42	1·83	1·20
Carbonate of Magnesia,	1·86	2·63	1·23	1·3	3·20
Carbonate of Strontium,	1·9	·02	·02	·04	·02
Carbonate of Lime,	2·66	3·60	3·60	3·82	2·76
Carbonate of Iron,	·03	·20	·02	·02	·1
Sulphate of Soda,	1·81	1·63	1·83	2·01	1·86
Phosphate of Soda,	·8	·03	·3	·93	·3
Arsenic,	·009	·038	·007	·008	·008
Common Salt,	3·28	2·114	3·23	2·857	3·415
Temperature in degrees F.,	105°·8	62°·6	89°	71°·6	59°

The quantity of carbonic acid is from 12 to 13 cubic inches.

The springs of Vichy are the typical alkaline springs, the carbonate of soda being the chief ingredient, the other constituents existing in such small quantity that it is impossible to estimate their exact influence on the action of the waters, though they probably modify the effects on the body. The remarks that have been made on alkaline waters in general fully apply, therefore, to the Vichy waters. The chief complaints because of which recourse is had to Vichy are urinary affections, catarrh of the bladder, stone and gravel; many gouty and rheumatic patients resort to Vichy, the latter class specially for the baths. Catarrh of stomach and bowels, enlargement of the liver and spleen, various disorders of digestion, heart-burn, painful digestion, gall-stones, and biliary colic are also suitably treated by a course of Vichy waters. Vichy water is the chief mineral water for use in diabetes, and in the milder forms of the disease is said to produce marked improvement. Vichy and Carlsbad are the two chief waters for this purpose. The Vichy waters and baths are also much used in uterine affections. Corpulence is also effectively treated by these waters. It is to be noted that the Mesdames spring contains more iron than any of the others, and it is, accordingly, employed for the weaker class of patients. Hauterive, and a spring resembling it, Celestins, is said to be less suited than Grande-Grille and Hôpital for irritable and nervous patients.

The bottled waters are taken before meals, from ½ to 2 pints being consumed daily, and they are used to stimulate digestion and remove acidity. The lozenges, "pastilles digestives," are similarly used, four, five, or six being taken before meals, while the dry Vichy salts are used for baths. Each packet contains ½ lb., the quantity needful for one bath.

The season at the springs begins on the 15th May and closes at the end of September; but the thermal establishment is open all the year, and October and November, and from February onwards, are not unfavourable times.

Besides the springs named, there are others, notably the spring Larbaud, and the spring Lardy, both provided with thermal establishments. The waters of both of these springs contain also a small proportion of iron, in the form of carbonate; the former containing ·2 grain in 16 ozs. and the latter ·16.

V. Soda Waters with Common Salt (Muriated Soda Waters).

It is not necessary to make any very detailed remarks upon this class of waters. The carbonate of soda is still the chief ingredient, and the common salt is believed to add to its effect and correct any tendency to bad results. It has been pointed out that soda tends to have a depressing effect on nutrition by hastening the destructive change of substance. This is believed to be partly, at least, the means by which fat is lessened and emaciation produced. The presence of any quantity of common salt, in addition, promotes the constructive portion of the tissue change. Thus Braun says, "Chloride of sodium (common salt) is an important corrective as regards both the local and the general effect of the carbonate of soda, . . . and, for most of the conditions requiring soda waters, a considerable amount of common salt in them is all the more to be recommended, the greater the amount of carbonate of soda which they contain. To this may be traced, in great part, the pre-eminence which, after years of experience, has been obtained by the waters of Ems and Selters, and even by Roisdorf, above pure soda waters, and the rapid prosperity of Gleichenberg, and especially of Luhatschowitz. It would be well worth the trouble in cases in which the strong soda waters of Vichy, Vals, Bilin, and Fachingen have failed in their effect, or have manifested bad incidental results, to render them muriatic alkaline waters by the corresponding addition of chloride of sodium." Whenever in addition to the correction of acidity of the stomach and bowels, &c., a stimulating effect upon digestion and tissue change is desired these soda waters with salt are to be preferred.

V. SODA WATERS WITH CARBONIC ACID GAS, AND CONTAINING ALSO COMMON SALT.

(Muriated Alkaline Waters, Muriatic Soda Waters.)

Name.	Situation.	Elevation above Sea in feet.	Amount of chief Constituents in 16 ozs.			Remarks.
			Soda in grains.	Common Salt in grains.	CO_2* in cubic in.	
Ems	Nassau	291	15	7	19	Warm springs.
Birresborn	Rhenish Prussia	1,100	20	7	17 grs.	Contains 9½ grs. bicarbonate magnesia and lime.
Gleichenberg	Styria	872	27	14	35	Cold. Carbonate of lime and magnesia, of each 4 grs. Several springs, one—the Klausner—contains ·66 gr. iron.
Kainzenbad	Upper Bavaria	2,400	4	—	—	Moor-baths. Excellent climate, good bath arrangements, climatic health resort. Sulphur and iron springs here also.
La Bourboule (Choussy).	Auvergne (France).	2,600	10	22	abundant	Warm springs. Contains also arsenious acid, ·08 gr. (See p. 951.)
Luhatschowitz	Moravia	1,600	33 to 61	23 to 33	14 to 50	Four different springs. Cold. Contains bromide of sodium ·255 gr., iodide of sodium ·132, and carbonate of iron ·111. Whey establishment.
Roisdorf†	Rhenish Prussia	1,000	9	3 to 14	19	Contains iron ·2 gr.
Royat	Puy-de-Dôme (Fr.).	1,380	5 to 9½	10 to 12	—	Warm springs, 66° to 96° F.
Selters	Nassau	800	10	17	30	
Vic-sur-Cère	Cantal	—	15	11	—	7 to 8 of sulphate of soda. Minute quantities of iron and arsenic. Used in liver and kidney affections.

* CO_2=Carbonic acid gas. † Exported only.

Other waters belonging to the same class are **Tönnisstein**, near Brohl on the Rhine, which has a cold spring, the water of which is exported, and **Szezawnica**, in Galicia, 1050 feet above sea-level, whose waters are cold, and richer in soda and salt and carbonic acid gas than Ems or Gleichenberg.

Ems is situated on the Lahn, in a narrow valley of Nassau, surrounded by wooded and vine-clad rocky heights. It is a few miles east of Coblentz and about 25 north of Schwalbach. The spring is at a little distance from the town, which now numbers nearly 7000 inhabitants, increased by 8000 visitors during the season. The climate is mild but moist, and in summer relaxing, specially so in July and August, so that May and June, September and October, are the best months. It is unsuitable for consumptives. Ems is easily reached from England, is provided with excellent hotels, and is quite a desirable place for

English needing its treatment. "There are few bathing resorts," says Braun, "where a sick person may find in intercourse with nature and man, and in the enjoyment of a brilliant and yet somewhat unpretending spa-life, such rich opportunity both for coming out of himself and for self-reflection; in both respects Ems is the pearl of Germany." The two chief springs are Krähnchen and Kesselbrunnen. The following table from Fresenius shows their composition in grains per 16 ozs.:—

	Krähnchen.	Kesselbrunnen.
Bicarbonate of Soda,	14·8	15·19
Bicarbonate of Magnesia,	1·505	1·436
Bicarbonate of Lime,	1·724	1·812
Bicarbonate of Iron,	·016	·027
Common Salt,	7·084	7·77
Sulphate of Soda,	·137	·006
Sulphate of Potash,	·328	·393
Carbonic Acid Gas,	83 cub. in.	67 cub. in.
Temperature,	84°·2 F.	114°·8 F.

Ems waters are specially employed for chronic catarrh of the air-passages, specially in gouty persons, as well as for disorders of digestion, sluggish liver, &c. A spring—Bubenquelle—used for bathing purposes, and particularly in the form of an ascending douche, used to be famous for disorders of the womb and sterility consequent upon them.

Gleichenberg (872 feet) "is situated in a pleasant hilly country," 7 miles from Gratz in Styria. Its waters are somewhat richer in carbonate of soda and in common salt than those of Ems, and "in a climatic point of view it deserves the preference." Its climate is mild, and the district is attractive.

Luhatschowitz, 2½ miles from the Hradisch station on the North-Austrian Railway, has springs rich in alkaline constituents, which serve all the purposes for which soda springs with salt are suitable. The climate is mild but moist, as it lies in a valley, though 1600 feet above sea-level.

Royat (1380 feet) is a little over a mile from Clermont-Ferrand, in a beautiful valley of the Auvergne Mountains. There are four springs, Eugénie, St. Mart, Cæsar, and St. Victor, of which the constituents in grains per 16 ozs. are as follows:—

	Eugénie.	St. Mart.
Bicarbonate of Soda,	9·443	5·12
Bicarbonate of Potash,	3·045	1·09
Carbonate of Lime,	7·000	3·71
Carbonate of Magnesia,	4·7	2·37
Carbonate of Iron,	·28	·14
Sulphate of Soda,	1·295	1·05
Phosphate of Soda,	·126	trace
Common Salt,	12·096	9·98
Chloride of Lithia,	·245	·22

Traces of arseniate, iodide, and bromide of soda.

The Victor spring is stronger than St. Mart, and in particular in iron, containing ·39 grain. The waters are largely used for gout and rheumatism, catarrhal affections of stomach and bowels, kidneys and bladder; and the St. Victor spring is specially fitted for delicate persons, sufferers from debility, bloodlessness, and for delicate women suffering from complaints connected with the generative organs. Royat is a good substitute for Ems, and its climate is preferable, especially in July and August. There is a thermal establishment fitted up with all modern bathing appliances.

Selters water is used only in the bottled form, and is not drunk at the springs. The town of Selters is a short distance from Schwalbach (p. 950). Tichborne's analysis—the most recent—is as follows (grains per 16 ozs.):—

Bicarbonate of Soda,	4·7
Carbonate of Lime,	2·2
Carbonate of Magnesia,	2·15
Chloride of Magnesia,	1·50
Carbonate of Iron,	·15
Common Salt,	16·24
Chloride of Potash,	·24
Sulphate of Soda,	·21
Phosphate of Soda,	·31
Carbonic Acid,	30 cub. in.

VI. Sulphur Waters.

Sulphur waters are those which contain sulphuretted hydrogen gas in solution. This gas is a compound of sulphur and hydrogen, and its chemical symbol is H_2S. It is a gas of a very fœtid smell, familiar enough to everyone as produced in the decomposition of albuminous materials. It is the development of this gas which causes the particularly offensive smell of rotten eggs. Sulphur waters either contain this gas in solution, or they contain substances which by chemical changes yield the gas. Such substances are chiefly sulphides, sulphides of soda, lime, potash, and magnesia, and to some extent also sulphates.

Sulphur waters are used both for bathing and for drinking purposes. Whatever may be the effects of sulphur waters when taken internally for any time, it is now generally believed that baths of sulphur water cannot produce any effect, which cannot equally well be produced by ordinary warm baths. It is pointed out that the quantity of sulphuretted hydrogen in most of the waters is so small that it can hardly have any specially stimulating effect upon the skin, and that in the ordinary bath no chemical change occurs to produce more of the gas, a change which, however, may occur in the stomach when

the water is drunk. It is also pointed out that no indications of sulphuretted hydrogen having passed into the blood through the skin are ever produced. Braun, therefore, concludes that the sulphur baths are probably nothing better than ordinary water baths. It is also to be remembered that the most famous sulphur baths are those of the Pyrénées, where all the advantages of mountain air and elevated situation combine with the courses of baths and waters.

It is, however, admitted that valuable effects are produced when sulphur waters are taken internally, and it is to the sulphuretted hydrogen actually present in the water when it is drunk, or produced from sulphides after drinking, that much of the beneficial effect is due. The sulphuretted hydrogen passes from the stomach into the blood, proceeding to the liver, and combines with blood corpuscles in course of breaking down, leading to their speedier removal from the body. During a course of such waters the motions become dark and finally black in colour, due it is said to the expulsion of this waste from the liver. Evidence of such a quickening of destructive change in the blood is found in the production of some amount of poverty of blood, requiring the use of a generous meat diet, and sometimes a course of iron waters subsequent to the sulphur.

On this account sulphur waters are employed in cases of torpid and enlarged liver, in cases of piles, in cases of catarrh of the air-passages, associated with such conditions of the liver and bowels, in early cases of consumption, and in various other affections of the lungs. How far the benefit experienced by sufferers from such lung affections is due to the sulphur water and how far to the mountain air of the resort is an interesting question. Various skin diseases, old ulcers, gunshot wounds, gout, rheumatism, and syphilis are also treated by the baths; and cases of chronic metallic poisoning, especially lead poisoning, are benefited by courses of the waters. The liver is the chief organ where metallic poisons are deposited, and it may be that the action of the sulphur on the blood flowing to the liver facilitates the removal of the deposits. The drinking of sulphur water is attended rather by constipation than by relaxation of the bowels, and they do not improve the appetite as do most other mineral waters, though they do not impair it.

At many of the sulphur water resorts the remedy is employed not only in baths and courses of the drinking waters, but by inhalation of the gas escaping from the water. This is thought to be serviceable in affections of the air-passages and in consumptive disease of the lungs. The air inhaled contains of course only a very small percentage of the sulphuretted hydrogen, for the inhalation of any quantity of the gas produces symptoms of poisoning, giddiness, faintness, headache, trembling, and in fatal quantity convulsions and delirium. Even a small percentage of the gas in the air will produce feelings of general discomfort and headache.

It has been already pointed out (p. 827) that some of these waters are employed to yield up their sulphuretted hydrogen for injection into the bowel as a treatment for consumption.

The table on the following page contains the names and chief facts concerning most of the sulphur waters in use; and only of a few of these will any further remarks be made.

Aix-les-Bains, in French Savoy, is one of the most fashionable and frequented of spas, chiefly on account of the baths, for which the arrangements are on a most complete scale, every variety of bath being provided, and inhalation chambers also. The town is in a beautiful neighbourhood, at an elevation of 850 feet, and very near some of the pleasantest scenery in the Alps. Living is moderate, there is agreeable society, and it will be found on the whole one of the most pleasant of resorts. It is a station on the railway from Paris to Mont Cenis, an eleven hours' journey from Paris, and a three hours' journey from Geneva. The springs are hot; the waters are abundant, yielding a million gallons a day; and they are chiefly used for baths in rheumatism, gout, sciatica, and nervous affections. Though the waters are used for drinking, they are too weak to yield the full effects of sulphur waters, but near to Aix are the sulphur springs of **Marliox**, which are cold and can be used for drinking in combination with the hot baths of Aix. Near to Chambéry, nine miles from Aix, is the spring of **Challes**, a strong sulphur water, containing also iodides and bromides, which is brought to Aix-les-Bains to compensate for its weak waters. The season begins early in May and lasts till October, though during the latter part of July and the early part of August the heat is rather great for comfort.

Aix-la-Chapelle or Aachen, the *Aquis Granum* of the Romans, between Brussels and Cologne, is the chief sulphur bathing resort of Germany. It is a town of over 85,000 inhabitants. The baths are exceedingly complete, though the surroundings are not nearly so engaging as those of Aix-les-Bains. The considerable quantity of

VI. SULPHUR WATERS.

Name.	Situation.	Altitude in feet.	Temperature of Spring in degrees Fahr.	Cubic Inches of Sulphuretted Hydrogen in 16 ozs.	Chief Constituents in grs. per 16 ozs. Common Salt.	Carbonate of Soda.	Sulphates.	Carbonates of Magnesia and Lime.	Sulphides.	Remarks.[1]
Abano	near Padua									
Aix-les-Bains	Savoy	850	107° to 113°	0	·1	·1	1·7		0	·07 iron.
Aix-la-Chapelle (Kaiserquelle)	Rhenish Prussia	534	129°	0·6	20	5	3·2	1·6	·07	Iron ·07.
Allevard-les-Bains	Isère (France)	1,473	61°	Rich in this gas and in carbonic acid gas.	3½		9	2		
Amélie-les-Bains	East Pyrénées	680	108°	trace	1/10		·8		·24	
Ax	Ariège (Fr.)	2,300	60° to 90°	Has no less than 53 springs.					·002	
Baden (Römerquelle)	Austria	638	95°	·08 to ·6	2	½	4		·36	
Baden	Switzerland	1,180	117° to 122°	small	13		13	2½	13	Mild in winter.
Bagnères de Luchon	Central Pyrénées	2,000	63° to 132°	trace	½		·9		·4	Mild climate and excellent accommodation.
Barèges	Hautes-Pyrénées	4,200	87° to 113°	trace	⅓		4		·36	
Battaglia	near Padua									
Buffalo Lithia Springs	Virginia, U.S.	(see p. 946).								
Builth	Wales	Weak sulphur well.								
Burtscheid	near Aix-la-Chapelle		136°	·12	21	5	9	1·3	4·8	
Cauterets	Hautes-Pyrénées	3,250	102·2°	traces	⅓		·3		·14	
Challes	Savoy (see p. 942).									
Eaux Bonnes	Basses-Pyrénées	2,434		·14	2		1½			
Eaux Chaudes	Basses-Pyrénées	2,215	79°	trace	1		10		·05	
Eilsen	North Germany	250	54·5°	1·5			9¾	1½	9¾	·4 iron, 1½ cub. in. CO_2.
Enghien	Seine-et-Oise, near Paris	52	50° to 57°	abundant						
Grosswardein			110°	5·3 (?)		6	9	4½		3 cub. in. CO_2.
Gurnigel	near Thun	3,787								
Harkany			136°	4	2·3			9		
Harrogate (old sulphur well)	England	600	cold	·66	86			1·2	1½	2½ cub. in. CO_2.
Helouan	4 miles S. of Cairo		90°	trace	·05	Good bathing arrangements.				
Heustrich	Berne	2,000				6				
Kainzenbad (Gutiquelle)	Bavaria	2,400		3·9		4	¾			
Spring at Kreuth	Bavaria	2,911	52°	·2			19½	9·7		·25 iron.
Langenbrücken	Baden	440	52°	·13 to 3			1	2·3		20 cub. in. CO_2.
Le Vernet	East Pyrénées	2,000	Hot sulphur springs used for baths. Visited in winter by persons with delicate chest, because of mild climate.							
Lisdunvarna	20 miles from Ennis (Ireland)			·5						
Llandrindod	Wales									
Llanwrtyd	South Wales			·5	6·4					
Mehadia	Hungary		70·7° to 130°	½ to 1	7 to 31		⅓	½		
Meinberg	Principality of Lippe-Detmold	634		½			16	2	·06	
Moffat	Scotland	400	Cold	·137	6·9			·46		Chloride of lime and magnesia 14.
Nenndorf	Westphalia		63·5°	·4 to 1·18			9 to 15	3 to 4		4 to 8 cu. in. CO_2.
Panticosa	Spain	5,000	77° to 91·4°	Rich in H_2S and nitrogen. Used for chest affections.						
Pystjan (Posteny)	Upper Hungary		111°	·47			6½			
Saint Sauveur	Hautes-Pyrénées	2,360	93·5°							
Schinznach	Switzerland, 2 hours from Baden	1,080	95°	1·7		1	10	1		2½ cub. in. CO_2.
Stachelberg	Switzerland	2,178	Cold.							
Strathpeffer (upper well)	Ross-shire, Scotland			3½ per 20 oz.			7½			16 grs. lime salts.
Töplitz Warasdin	Croatia	900	136°	6½	1		3½	3½		3 cub. in. CO_2.
Uriage	Isère (Fr.), near Grenoble	1,300	80°		59		37 of soda and magnesia	15		
Weilbach	Nassau, Prussia	420	57°	·16	2	3	·3	5½		3 cub. in. CO_2.
White Sulphur Springs	West Virginia, U.S.	2,000	62°	·02			6½	½		1 cub. in. CO_2.

Abano and Battaglia, on the line from Padua to Bologna, are hot springs from the Enganean range, stronger in salt than but otherwise similar to Aix-la-Chapelle.

Lavey, in the Rhone valley, near the station St. Maurice, 1420 feet high, has hot sulphur springs with common salt and sulphate of soda.

[1] CO_2 means carbonic acid gas.

common salt in the water is noted in the table, and doubtless much of the efficacy of the water is due to it. The waters are used for drinking as well as for baths. Drawn from the spring it is very hot, and visitors sip it as they promenade up and down. They usually begin with 6 or 8 ounces, and gradually increase to a pint or a pint and a half. The baths are usually prolonged from a half to three-quarters of an hour. Rheumatism, gout, nervous cases, syphilis, stiff joints, skin diseases, diseases of liver and abdominal derangements generally, and cases of metallic poisoning are treated here. The season is from June to the end of September, but the baths are open all winter. The water is exported also. **Burtscheid** is situated so near Aix-la-Chapelle that it may be called a suburb, but its springs though hotter are less strong in sulphur.

Amélie-les-Bains (680 feet), in the Pyrénées, 24 miles south of Perpignan, is provided with all sorts of bathing arrangements, which are specially employed in rheumatic cases, and with arrangements for inhalation, used in cases of consumption, for which its mild climate is specially suited. It is also suitable for a winter residence.

Allevard-les-Bains (1473 feet), in south-eastern France, has of late come into repute for the treatment of chest affections, bronchitis, asthma, &c., and also for skin affections and rheumatism. It is two hours' journey from Grenoble, and six from Lyons or Geneva. The nearest station is Goncelin.

Barèges (4200 feet), 12 miles from the railway-station of Pierrefitte, is one of the highest and most famous springs of the Pyrénées. It is resorted to for paralysis, rheumatism, old wounds, skin diseases, and bone diseases. The accommodation, however, is poor, and the surroundings dismal. A peculiar organic matter of a gelatinous nature found on the surface of the water is called **baregine**, from the name of the town. The season is July and August.

Bagnères de Luchon (2000 feet), in the valley of Luchon, 5 hours' journey by rail from Toulouse, is surrounded by the splendid scenery of the Pyrénées. Although this water contains very little sulphuretted hydrogen, yet as soon as it is drawn into the bath it becomes milky, as if from the deposit of sulphur, and the gas is developed and escapes into the air, which immediately above the bath contains as much as 1 per cent of the gas. It has been supposed that silica contained in the water takes part in this change.

Cauterets (3250 feet), in the Hautes-Pyrénées, 6 miles from Pierrefitte railway-station, is much frequented by persons suffering from chest affections. Chronic rheumatism and skin diseases, uterine affections and early stages of consumption are also treated. The situation is high, and much of the benefit may be due thereto, though horses "from the studs of Tarbes and Pau, which are afflicted with chronic bronchial and stomach catarrh, diarrhœa, emaciation and spermatorrhœa, are sent to the springs at Cauterets, and are often cured there in a week" (Braun). The climate is variable; and the best months are July, August, and September.

Eaux Bonnes is situated in the Pyrénées at an elevation of 2434 feet, in a narrow sheltered ravine, at the foot of the Pic du Gers, and is reached from Pau, from which it is distant 20 miles. The climate is subject to sudden changes of temperature, but the situation and scenery are very attractive. It is said to produce excellent results in clergyman's sore throat and lung affections, specially of the tubercular kind, which may be due to the elevated situation. The water is taken in very small quantity to begin with, a table-spoonful or so, and is cautiously increased to 4 or 5 glasses daily.

Eaux Chaudes (2215 feet), also in the Pyrénées, is reached by diligence from Pau, and is situated in a narrow and picturesque but gloomy gorge, and subject to rather sudden changes of temperature. The waters are chiefly used for baths in cases of chronic rheumatism, muscular rheumatism, and chlorosis and neuralgias. It is 4 miles distant from Eaux Bonnes. The season is from 1st June to 1st October.

Harrogate is in Yorkshire, 30 miles west of York, partly situated on high ground (600 feet) and partly in the valley. The air is pure and bracing but moist, and the soil is sandy and readily dries after rain. It contains not only sulphur wells which are among the strongest known, but also iron springs. There are considerable social attractions, and during the season, June to October, the climate is pleasant. The waters are taken between 7 and 8 a.m., and the dose is from one to three tumblerfuls, a short walk being taken between each glass, the third being followed by a longer walk back for breakfast. The waters open the bowels, acting upon the liver also, and removing constipation. They are thus useful also for sluggish liver, abdominal congestion and piles, especially when resulting from rich living. They also promote change of tissue and are used as a

remedy for corpulence and for the removal of thickenings of glands and gouty and rheumatic swellings. They are useful for full-blooded persons with a tendency to apoplexy, also in cases of enlargement of the womb; and it is a favourite resort for overworked business men. A course of eight days to three weeks is usually taken in the quantities already named, when the opening action is chiefly sought, and when the waters are taken to promote tissue change from 2 to 8 ounces is the quantity taken cold three or four times a day. If the waters lie heavy on the stomach they are taken warm. Chronic rheumatism, gout, and syphilis are also treated. Cases of threatened consumption, and disorders of the monthly illness in young persons are treated with the sulphur baths, and the iron waters internally. Much of the effect of the sulphur waters is believed to be due to the large quantity of common salt contained in the waters.

Moffat in Dumfriesshire, Scotland, is an excellent health resort in summer and up to the middle of September. Its climate is good, and much picturesque scenery is within easy driving distance. The well is fully a mile from the town; the waters are very mild but generally suitable for cases similar to those described for Harrogate. A hydropathic establishment is within a mile of the railway-station.

Saint Sauveur (2360 feet) is a fashionable "ladies' bath," being much used by women for nervous complaints and affections of the generative organs. It is approached from Lourdes, is 4 miles from Barèges and is close to some of the finest scenery of the Pyrénées. The season commences in May and ends in October.

Strathpeffer, amid wild and picturesque scenery at the foot of Ben Wyvis in Ross-shire, Scotland, is becoming more frequented since the building of a suitable establishment near the wells. There are two springs, the upper being the strongest sulphur spring in Britain. The water acts strongly on the kidneys, but is constipating owing to the large quantity of lime salts. Three tumblers are usually taken before breakfast and as many more in the afternoon. Chronic cases of sciatica, lumbago, and rheumatism find relief; and the water has a strong effect on the skin, shown by the cuticle coming off in scurf.

Lisdunvarna, in Ireland, about 20 miles from Ennis, possesses a sulphur spring, containing ½ a cubic inch of sulphuretted hydrogen in 16 ozs., and several iron springs, but the place has no suitable arrangements for visitors.

VII. Earthy Mineral Waters (Lime Waters).

The earthy mineral waters are those in which lime is a prominent constituent. It occurs in the form of carbonate and sulphate. Of the two, the carbonate is the salt to be desired, and the sulphate of lime in any quantity equal to 10 grains or upwards is undesirable, because it lies heavily upon the stomach and lessens the absorption of the water into the blood. Carbonate of magnesia is another salt which occurs specially in earthy mineral waters, and is more readily absorbed than the lime salts.

It was believed at one time that these waters had a special value in diseases of bone, in rickets, in the disease called osteomalachia, because they supplied lime to the system, a deficiency of which was supposed to be at the root of the disorder. It is quite clear, however, that abundance of lime salts is supplied in the food eaten and in water, and that the disease is not due to deficiency of the phosphate of lime, but to some digestive derangement or to some disorder of the tissues which prevents the lime salts obtained from the food being made proper use of in the body. Consequently such bone diseases are treated by appropriate food, tonic treatment of various kinds, and change of air. Lime waters have, however, other uses. They correct acidity of the stomach and bowels, and they appear to be useful in gravel and in kidney and bladder affections. They are somewhat constipating, and, therefore, useful in diarrhœa and irritable conditions of the bowels. They have a reputation in scrofula, gland diseases, and tubercular disease, but there is no satisfactory reason for such repute. Earthy waters are used as baths, but the lime salts they contain are of no effect, and do not modify the action of the simple water.

Many of the waters already named contain considerable proportions of lime salts; thus of the waters named in the last table the water of Baden in Austria contains 5 grains of sulphate in 16 ounces, Baden in Switzerland 10 grains, Eilsen 17 grains, Grosswardein 2 to 3 grains, Nenndorf 5 to 8 grains, Schinznach 6 grains, Pystjan 4 grains, Töplitz 1 to 3 grains, while carbonate of lime is contained in Eilsen water, that of Aix-la-Chapelle, Baden near Vienna, Baden in Switzerland, Grosswardein, Nenndorf, Harkany, and Weilbach. In Table II., Baden-Baden, Canstatt, Cronthal, Dürkheim, Homburg, Mergentheim, Mondorf, Nauheim, Pyrmont, Schmalkalden, and Wildegg have been

mentioned as containing various quantities of these lime salts. In Table III. the presence of sulphate of lime in several of the bitter waters is noted in some quantity, and in Tables IV. and V. the presence of carbonate of lime in the soda waters. In all these waters the lime salts have been unimportant constituents in comparison with the other ingredients, worthy of note only when present in such quantity as to make the water difficult of digestion. In the present waters, however, the absence of other ingredients in quantity makes the lime salts the chief feature of the water. For this reason it must be understood the table does not include all waters containing lime salts in any proportion, in which case it would be of great length, but only those in which they rank as the chief ingredients from the absence of others.

VII. EARTHY MINERAL WATERS (WATERS CONTAINING LIME).

Name.	Situation.	Altitude in feet.	Chief Constituents in grains per 16 ozs.					CO_2* in Cubic Inches.	Remarks.
			Lime as Carbonate.	Lime as Sulphate.	Other Carbonates, Soda, Magnesia, &c.	Other Sulphates, Potash, Soda.	Common Salt.		
Alet	Aude (France)	650	1·89	·2	·8	—	·3		Used in stomach and bowel affections.
Bethesda	Wisconsin, U.S.A.	—	2·04	—	1·6	·1	·139		Prescribed in kidney and bladder diseases and in diabetes.
Buffalo Lithia	Virginia, U.S.A.	500	1½ to 4	2 to 3	·15 to 3	1	$\frac{1}{10}$ to ½	1 to 6	½ cubic in. sulphuretted hydrogen.
Chateldon	Puy-de-Dôme, France		3·61	·35	4½	—	·2	15 grains	·245 iron.
Condillac	Vaucluse (Fr.)	Imported as a table water.							
Contrexéville	Vosges (Fr.)	1,000	2¾	8	⅕	1¾	—	½ grain	
Couzan	France								
Cransac	near Aubin in Auvergne	Besides sulphates of lime and magnesia contains 13 grains sulphate of alumina in 16 ozs. Used in enlargements of liver and spleen, and intermittent fever.							
Inselbad	Westphalia		2	0	—	0	6	trace	·02 iron, 2·78 cub. in. of nitrogen; used for inhalation in cases of consumption.
Johannisbrunnen	From spring near Niederselters in Nassau.		3½		2¾	½	15	abundant	A sparkling table water.
Leukerbad (Lorenzspring)	Switzerland	4,670	0	10½	—	nearly 3	(see p. 927).		Warm, contains ·079 iron.
Lippspringe	Westphalia	441	5	2	—	7¾	nearly 2	5	·1 iron.
Lucca	See Table I.								
Poland Spring	Maine, U.S.A.	800	·135	Practically an indifferent water. Used specially in kidney disease and diabetes. Excellent accommodation.					
Pougues	Loire (France)	780	9·28	1·33	11·2	1·89	2·45 chloride of magnesia	little	·14 iron.
St. Galmier (Source Nouvelle)	Loire (Fr.)	1,350	with magnesia 3·4	with soda 1·2	3	·55	1·5	abundant	·06 iron, an excellent table water.
Sulis	See Bath, p. 925								
Taunus	Table water from spring near Frankfort-on-the-Main	390	9½	½	1·3	—	18	20 grains	
Weissenburg	near Thun	2,758	0	17		5		¾	
Wildungen	Waldeck	740	5 to 9	0	5 to 16	⅓ to ½	8	33	

* Carbonic acid gas.

Bethesda and Buffalo Lithia Springs are both in the United States of America. The former is at Waukesha, in Wisconsin, and the latter in Virginia. I have no authoritative statement as to their physiological action and curative effects. Bethesda water is, however, lauded in Bright's disease of the kidney and in various kidney and bladder affections, and very specially in diabetes. The Buffalo water is deemed valuable on account of the carbonate of lithia it contains to the extent of from ·148 to ·225 of a grain in 16 ounces. It is recommended in gout, rheumatism, gravel, disease of the kidney, specially chronic Bright's disease, and bladder, and in stomach and bowel disorders. It is said to contain sulphuretted hydrogen. Both are to be had in bottles.

Contrexéville (1000 feet) is situated in a narrow valley of the Vosges Mountains, over a thousand feet above sea-level. It is subject to sudden changes of temperature both morning and evening, a fact visitors should remember. It has a special reputation in the treatment of gravel and stone, as well as diseases of the

kidney, catarrhal affections of the bladder and prostate gland, in gout and liver disorders, in incontinence of urine in children, and in diabetes. Patients begin with two or three glasses in the morning before breakfast and gradually increase the quantity to 12, 15, or upwards. There is a well-equipped bathing establishment, and abundance of hotels. There are several springs, the Pavilion being the chief. Its waters contain a small quantity of iron, ·05 grain in 16 ounces, and a trace of arsenic. The water is largely exported. From half to one bottle is taken daily with food as a table water, or in milk or wine or spirit. The season is from 20th May to 15th September.

Lippspringe and Inselbad, near Paderborn in Westphalia, are specially resorted to in consumption and other affections of the chest. One to three glasses of the water are drunk in the morning and one or two in the afternoon. Baths are also employed. The repute of the place is to some extent due to the nitrogen gas contained in the waters, which is given off in chambers in which patients inhale it.

Pougues (780 feet) at one time enjoyed great popularity for dyspepsia and bladder irritability and catarrh. It lies in the valley of the Loire, not far from Nevers, in a pleasant country, and much has lately been done to restore its celebrity. Its waters are imported.

Weissenburg lies in a narrow gorge off the Simmenthal in Switzerland, 3 miles from Thun, surrounded by mountains and pine-trees. "The air is calm, mild, and moist, but the weather variable." It has a great reputation in cases of chronic bronchial catarrh and consumption, believed to be due rather to its elevation (2758 feet), its sheltered situation, calm air, and atmosphere of pine-wood, than to its spring.

Wildungen lies in a valley of Waldeck, 300 feet above sea-level. It is three hours' journey from the Wabern station on the Main and Weser railway. Its two chief earthy springs are the Georg-Victor-quelle, and the Helenen-quelle, and it has besides an iron spring. The Georg-Victor has 5·4 and the Helenen 9·7 grains of carbonate of lime. There is no lime sulphate, but the sulphates of soda and potash are ·6 and ·3 respectively. The Helenen-quelle contains 8 grains of common salt in 16 ounces and 6 of bicarbonate of soda, 10·4 of bicarbonate of magnesia, ·143 carbonate of iron, and 34 cubic inches of carbonic acid gas, while the quantities in Georg-Victor are ·06, ·49, 4·1, ·161 grain, and 33 cubic inches of gas. The third spring, Thalquelle, contains 6·67 common salt, 10 bicarbonate of lime, 9·8 bicarbonate of magnesia, ·1 carbonate of iron, and 33 cubic inches of gas. The water, specially the Georg-Victor spring, is much used in chronic catarrh of the bladder, incontinence of urine, in gravel, and other affections of the kidney.

VIII. Iron Waters (Chalybeate Springs).

Iron or steel waters are not the only mineral waters in which some form of iron is found. Indeed in nearly all mineral waters this ingredient exists, but in very many in such small quantity, while other ingredients are so conspicuous, that the character of the water can hardly be supposed to be affected by that metal. There is no stated amount of iron which entitles a spring to be classed as chalybeate, though those most successfully resorted to contain from $\frac{1}{3}$d to $\frac{9}{10}$ths of a grain of iron in the form of carbonate in 16 ounces. Some springs are classed as iron springs which contain barely $\frac{1}{5}$th of a grain in 16 ounces of water, but they are so because they have been found by the actual experience of cases to have the beneficial effects of steel waters. Indeed it is rather the experience of the value of the water in particular forms of disease than the actual quantity of iron it contains that determines how it should be ranked. What are called **pure iron springs** are those which contain but a few grains of dissolved solids, a salt of iron existing to some appreciable amount; **compound iron springs** contain moderate quantities of other salts, such as Epsom and Glauber's salts, common salt, sulphate of lime, besides being rich in carbonic acid gas. To this class some of the springs already named are entitled to belong, such as Franzensbad, Marienbad, Tarasp, Elster. We take the following list of springs containing iron from Braun, springs which we have already considered, and we note the amount of iron in the form of carbonate which each contains in grains per 16 ounces:—

Common Salt Waters (Table II. p. 929).

	Grains of Iron in 16 ozs.
Cronthal, Ischl, Mergentheim, Wiesbaden,	·04 to ·05
Adelheidsquelle,	·07
Baden-Baden, Canstatt, Mondorf, Nauheim, Schmalkalden, Soden,	·05 to ·25
Hall,	·08

	Grains of Iron in 16 ozs.
Dürkheim,	·12
Kissingen,	·2 to ·24
Harrogate (Montpellier Spring),	·27
,, (Kissingen Spring),	·37
Kreuznach,	·35
Rehme,	·5

Bitter or Aperient Waters (Table III. p. 934).

	Grains of Iron in 16 ozs.
Carlsbad,	·01 to ·02
Franzensbad,	·01 to ·37
Rohitsch,	·06
Füred,	·08
Tarasp,	·19 to ·2
Marienbad,	·27 to ·47
Elster,	·35 to ·48

Soda Waters (Tables IV. V. pp. 937, 940).

	Grains of Iron in 16 ozs.
Giesshübel,	·004
Ems,	·01 to ·05
Salzbrunn,	·04 to ·07
Preblau,	·05
Roisdorf,	·05 to ·2
Apollinaris,	·06
Selters,	·07
Bilin and Fachingen,	·08
Luhatschowitz,	·09 to ·18
Gleichenberg,	·14 to ·18
Geilnau,	·16

The reason for the use of iron waters is that iron is a necessary ingredient of the blood (see pp. 216 and 816), and in certain conditions promotes the formation of blood. But the total quantity in the blood does not exceed 40 grains, and it has been estimated that in health the quantity taken up into the blood per day does not exceed 1 grain, though in some cases of poverty of blood, chlorosis (p. 235), 4 to 5 grains may be taken up and incorporated. The most useful springs will yield from ·14 to ·42 grain of iron in 16 to 48 ounces of mineral water. But food contains iron salts. It is, indeed, from the food that the continual renewal of iron to the blood takes place, flesh meat, yolk of egg, wheat, barley, and lentils, containing considerable proportions of the metal. When this condition of poverty of blood exists, it affects all the bodily functions, and the powers of digestion and assimilation are so enfeebled that full advantage is not taken of the food supplied, and so the condition tends to persist. Under such circumstances the change of air, and the general beneficial influences exerted upon the whole body by the life of the spa, have such stimulating effects upon the nutritive processes that there can be no doubt much of the benefit is due to quite other circumstances than the mere presence of iron in the water drunk. Besides that the presence of other ingredients of the spring, carbonic acid gas, common salt, &c., is stimulating to the stomach and bowels and tends directly to the improvement of the nutrition. It is, at any rate, plain that when such a small total quantity of iron exists in the blood, and such a small quantity is daily made use of, only small doses are necessary. If excessive doses be given, the excess is passed off in the motions as a sulphide of iron, blackening them, and is apt to irritate the stomach and bowels, to interfere with digestion, and to produce constipation. When small doses are given more is actually absorbed into the blood than when large quantities are taken. The conditions, therefore, in which iron springs are most likely to be useful are pretty plain. They are those in which one seeks to promote blood formation, those dependent upon poverty of blood. It has been found that iron springs are most useful in cases of poverty of blood quickly produced, for example, by loss of blood, by bleeding from the nose, or from wounds, by drain occurring from the blood owing to diarrhœa, suppuration, and other profuse discharges, in cases of chlorosis in young girls, and in poverty of blood dependent upon acute disease, in which cases they materially promote convalescence. Iron springs are also used in disorders of monthly illness, specially in its absence, in malarious conditions and poverty of blood due to residence in tropical countries, and in neuralgia, sterility, and impotency due to enfeebled conditions of general health. In such cases as these last the improvement is not so rapid, and is often best promoted by waters which, besides the iron, contain marked quantities of other ingredients like common salt.

It is chiefly in the form of carbonate that the iron exists, and this is the best form for administration. The presence of carbonic acid gas in the water keeps the carbonate of iron in solution, and when the water stands a yellowish rust is deposited.

If constipation be associated with the bloodless condition, a spring should be chosen which contains common salt, or Glauber's or Epsom salts to correct this condition, and if a pure iron spring causes costiveness or diarrhœa and indigestion, a change in a similar direction must be made, such as Marienbad, Franzensbad, Elster.

Iron springs are used for bathing, but it is not now believed that the iron they contain produces any effect upon the skin, or is absorbed from the bath. They have no further effect than baths of plain water, except what is due to the stimulating effect of any carbonic acid

VIII. IRON WATERS (CHALYBEATE SPRINGS).

Name.	Situation.	Altitude in feet.	Ingredients in grains per 16 ozs. Carbonate of Iron.	Carbonates of Soda, Lime, Magnesia.	Sulphates, Soda, Lime, &c.	Common Salt and other Chlorides	Carbonic Acid Gas in cub. in. per 16 ozs.	Remarks.
Alet	Aude, France							
Alexisbad [1]	Harz Mountains	1,350	·35	Only 3 grains other constituents.			10	
Altwasser [1]	Silesia	1,255	·3 to ·7	4·7	½ to 1		4 to 27	
Antogast	Badish Black Forest	1,585	·23	20 grs. other constituents.				
Arapatak	Transylvania		1·16 to 2·35	22 to 24			33	
Bartfeld	North Hungary		·67	16		5	45	
Bocklet (Stahlquelle)	Near Kissingen	620	·67	10	5¾	11	39	
Brückenau [1]	Bavaria	915	·09	1·8	¾		38	Hot.
Bussang	In the Vosges	Table water only. No establishment.						
Cheltenham	England		·88	6 grs. other constituents.				
Cudowa	Silesia	1,235	·2	13	5¼		33	Contains also arseniate of iron ·008 to ·012.
Driburg	Westphalia	633	·78	15	22		28	
Elster (see Table III.)			·35					
Flinsberg [1]	Silesia	1,550	·25	Only 2 to 6 grains other ingredients.			27	
Franzensbad	Bohemia	1,293	·3	See Table III.				
Freienwalde [1]	On the Oder		·17 to ·26				little	
Freiersbach	Black Forest	1,280	·7	6½	2		14	
Godesberg	Near Bonn		·2	12		7·3		
Gonten [1]	Appenzell Canton (Switzerland)	2,761	·33					
Griesbach	Baden	1,614	·6	13	8		18	
Harrogate [1]	England	420	Chloride of iron 1·32, carbonate 1·1.			43·9	2 to 2½	
Heinrichsbad	Canton Appenzell	2,410						
Hofgeismar	Hesse	328	·2 to ·4	Only 21 grs. other ingredients.				
Homburg (Stahlbrunnen). See p. 930.								
Imnau	Hohenzollern	1,430	·64	8	½	1¼	30	
Kainzenbad	Bavaria	2,480	See Table V.					
Kœnigswarth [1]	Between Franzensbad and Marienbad	2,000	·4 to ·65	Only 5 to 6 grains other ingredients.			30	
Liebenstein [1]	Thuringian Forest	1,000	·6	6	1½	nearly 2	32	
Liebwerda [1]	Bohemia	1,225	·17	Only 2·5 grains other ingredients.			22	
Lobenstein [1]	Principality of Reuss	1,500	·43					
Muskau [1]	Upper Lusatia (Prus.)	300	Sulphate of iron 1·52, carbonate of iron 1·38.		3½	½	traces	
Niederlangenau [1]	Glatz	1,137	·28	2½	Only 3½ grs. other constituents.		35	
Orezza	Corsica		·85	5			abundant	Traces of arsenic.
Petersthal	Baden	1,333	·35	15	6½	½	34	
Pyrmont	Waldeck	400	·37	10½	11	½	29	
Recoaro	North Italy	1,465	·23	5½	14½		18	Lukewarm.
Reinerz	Silesia	1,235	·29	12	½	$\frac{1}{10}$	35	
Rippoldsau	Baden	1,886	·9	12	8		15	
Santa Catarina	Upper Italy (3 miles from Bormio)	5,600						
Schandau [1]	Saxon Switzerland		·11					
Schwalbach [1] (Stahlbrunnen)	Nassau	900	·64	3½			50	
Shelfanger	Diss, Norfolk, Eng.		·29	2½	·46	·65		
Spa [1] (Pouhon Spring)	Belgium	1,000	·14	Total ingredients 3·9.			8	
St. Moritz	Switzerland	5,710	·2	8	2		31	
Sternberg [1]	Near Prague		·24	Total solids 4·7 grains.			8	
Tunbridge Wells [1]	Kent, England	300	·11					
Vichnye [1]			·95				6	
Wiesau	Bavaria	1,642						
Wildungen	Waldeck	740	·58	See Table VII.			18	

[1] Pure chalybeate waters; others are compound.

gas which may remain in the water after it is heated.

Antogast (1585 feet) is one of the Kniebis baths, which include also Freiersbach, Griesbach, Petersthal, and Rippoldsau. They all lie in the Black Forest, Duchy of Baden, and are reached from stations on the Baden Railway. They vary in the quantities of iron their springs contain, as Table VIII. shows, and they have the advantages of mountain elevation, forest air, and beautiful scenery. They are adapted for all cases of poverty of blood.

Bocklet (620 feet) is only 4 miles north of Kissingen, and the use of its waters is frequently advised after a course at Kissingen. Its spring is advantageous from the combination of common salt and carbonic acid gas with the iron. Bocklet itself is only a small village. Its atmosphere is healthy and invigorating, and from the absence of fashionable amusements it offers a pleasant quiet rural retreat for those who prefer a retired resort. It has a sulphur spring which also contains carbonate of iron to the extent of ·4 of a grain in 16 ounces. The steel springs are two in number, and contain about the same proportion of iron. There is good accommodation in the village as well as in the establishment connected with the springs. It is chiefly resorted to for female disorders.

Harrogate has already been considered under Sulphur Wells (see p. 944). It has also two chief iron springs, the Muspratt and the Tewitt. The latter is a pure chalybeate spring, containing ·135 grain carbonate of iron in 16 ounces. The Muspratt spring, the analysis of which is given on p. 943, is much stronger, and is given in doses of from 2 to 6 ounces three times daily, but it is much more apt to disagree than the water of the weaker spring. The use of these waters has been sufficiently indicated on p. 941.

Orezza is in Corsica, 20 miles from Bastia. "It is in a beautiful country and amidst forests. It is in great repute locally in cases in which iron is indicated, especially in chlorosis and some of the complaints of women, and is said to be a specific in malarious poisoning, which is common in many parts of Corsica, but only when it has not gone the length of producing engorgement of the liver or spleen. Its waters are largely exported. The season is short—from the middle of June to the 30th of August" (Macpherson). It may be used in cases of poverty of blood (anæmia) as a tonic table water.

Pyrmont has already been referred to in regard to its salt springs on p. 929. It was formerly much frequented and very fashionable on account of its iron spring. But it lies only 400 feet above the sea-level, and iron springs which have the advantages of a much higher elevation are now sought in preference, though its waters are well suited for cases where iron treatment is desired, and its arrangements and accommodation are excellent.

Schwalbach is one of the most popular and frequented of iron springs. It lies 951 feet above sea-level in a sheltered valley of the Taunus range, and may be reached by railway from Wiesbaden in an hour and a half. It is one hour's distance by road from Schlangenbad. While it has the benefit of mountain situation it is well sheltered, and its arrangements are excellent. "Everything that has been said of the effects of iron applies to Schwalbach, and there are few wells which answer in their effects to one's expectations better than these" (Macpherson). It has three chief wells—Stahlbrunnen, of which the analysis is given in the table; Weinbrunnen, with ·44 grain carbonate of iron in 16 ounces; and Paulinenbrunnen, with ·51 gr. carbonate of iron. The season is May to October.

Spa is one of the most accessible of continental baths from England. It is reached by a short branch from the railway from Brussels to Liège, the junction station being Pepinster, and the distance from Liège 17 miles. It lies in a beautiful valley of the Ardennes at an elevation of over 1000 feet, 20 miles from Aix-la-Chapelle. Sheltered from the north, it has a mild climate; the surrounding country is attractive; the bathing arrangements are luxurious; and riding on horseback is one of the favourite forms of exercise. It has no less than sixteen springs, the chief, Pouhon, being situated in the centre of the town. Mud-baths are also employed, the material being obtained from the peat soil in the neighbourhood of the town.

St. Moritz (5710 feet) as a health resort has been sufficiently spoken of on p. 796. Its steel springs are tolerably pure, and are pleasant from the abundance of gas they contain. Baths are also to be had. But the waters and baths are really secondary considerations in a residence at St. Moritz, the bracing effect of the mountain air and the magnificent scenery being the chief attractions for the large numbers who seek the restorative influences of this favourite resort.

Tunbridge Wells, 30 miles south of London, possesses a fairly pure steel spring. Its climate is healthy and bracing and its surroundings beautiful. Its waters are not taken advantage of to the extent they might be. Weber suggests that the addition of Selters or Apollinaris might make them more useful for some constitutions, because of the stimulating effect which the carbonic acid gas either of these table waters would supply.

IX. Iodine Waters.

A considerable number of the waters we have noticed contain minute quantities of iodine as iodide of sodium or magnesium, and also bromine in similar combinations. To the presence of

this ingredient much value was attached, especially in the treatment of scrofula in children, and in various other complaints. The springs which were specially classed as iodine or bromo-iodine waters were the Adelheids spring (p. 929), Dürkheim (p. 929), Hall (p. 929), Kreuznach (p. 931), Wildegg (p. 929), and Woodhall (p. 932). The quantity of the iodine compound is in every case so small that it is not now believed that it can produce any perceptible effect upon the body, except perhaps in the case of Woodhall. The waters are usually rich in other saline ingredients, to which their good effects are now attributed, and they have accordingly been noticed elsewhere.

X. Arsenical Waters.

What has been said of iodine waters is equally true of arsenical waters. The presence of minute quantities of arsenic is found in several waters, but the chief are La Bourboule (p. 940), St. Dominique (of Vals), and Mont Dore (p. 937). It has been estimated that to get a medicinal dose of arsenic 4 to 8 pints of the water would require to be taken daily, and as a rule the effect of this ingredient is scarcely calculated upon.

Court St. Etienne water, from a spring near Waterloo, in Belgium, discovered in 1878, is said to be one of the strongest and most permanent of arsenical waters. Tichborne's analysis gives ·083 grain arseniate of soda in 16 ounces, and this amount of arsenical salt is associated with less than 2 grains of other ingredients, so that it might be used as a pure arsenical water in cases where arsenic seemed indicated (see p. 823).

The Whey-cure.

The whey-cure is a method of treatment adopted at many health resorts, the whey being either sipped alone at a temperature of about 105° F., while the patient takes gentle exercise, or being added to the mineral water of the resort. In the former case not less than a pint daily is the quantity consumed, and from 4 or 6 pints are the largest quantities ordered. The whey is taken in the early morning, and breakfast is not taken till after an interval of an hour or more. In the chief whey establishments goats' milk is used for the production of the whey. The nature of whey has been explained on p. 550. It is milk deprived of its casein or curd, and most of its fat or butter. It thus contains a small quantity of albuminous material, a little fat (the clearer it is the less fat it contains), the sugar of milk, and the salts of milk (p. 551), chlorides, sulphates, and phosphates. The value of the whey is attributed partly to the sugar, and partly to the salts. The whey has a slight opening effect on the bowels, but is also apt to cause dyspepsia and catarrh of the bowels. The whey-cure is specially ordered for consumptive patients, and for persons with much cough, and irritation of the windpipe and large bronchial tubes. But these are just the cases which are now sent to mountain resorts, where indeed the chief whey establishments are, and the improvement effected is mainly due to the fresh mountain air. Braun doubts whether whey is not actually less useful than well-adapted courses of mineral waters, like those of Carlsbad or Marienbad, which stimulate stomach and bowels, and aid the appetite and digestion without producing catarrh.

Whey is to be had at nearly every mineral spa, but those which have a special repute in this way are stated below.

Alexisbad (p. 949).

Arco, in the Southern Tyrol.

Baden, near Vienna (p. 943).

Driburg (p. 949).

Elster (p. 934).

Ems (see p. 940).

Engelberg (canton Unterwalden, Switzerland), 3180 feet above the sea, reached from Lucerne.

Gais, in the canton Appenzell, 3064 feet above the sea.

Gleisweiler, 1000 feet above the sea, one hour from Landau in the Lower Palatinate.

Heiden, in canton Appenzell, Switzerland, 2645 feet above sea-level.

Heinrichsbad (p. 949).

Interlaken, Switzerland, 1863 feet above sea-level.

Ischl (p. 929).

Kreuth (p. 929).

Liebenstein (p. 949).

Meran (p. 797).

Montreux, 1186 feet above the sea, on the Lake of Geneva, near Vevey.

Rehburg, in Hanover, which has also saline and iron springs.

Reichenhall (p. 929).

Reinerz (p. 949).

Roznau, in Moravia, 1200 feet above sea-level.

Salzbrunn (p. 937).

Schlangenbad (p. 926).

Soden, in Nassau (p. 929).

Streitberg, in Bavaria, 1800 feet.

Waggis, at the base of the Righi, on Lake Lucerne, at an elevation of 1434 feet.

Weissbad, canton Appenzell, Switzerland, 2320 feet above the sea.

Most of these places, specially those of Switzerland, are favourite health resorts in summer, and many of them suitable for consumptive patients.

The Grape-cure.

The grape-cure has been referred to on p. 576, and in speaking of Meran on p. 797. Taken in quantity on an empty stomach grapes act upon the bowels, stimulate change of substance, and at the same time supply sugar and salts to the blood. From 1 to 8 pounds are consumed per day, partly taken before breakfast, and partly throughout the day. They are used for their opening effect in cases of sluggishness of abdominal organs and corpulence, and in lung affections for their stimulus to the general nourishment of the body. Braun says of this method of treatment, "All, however, that has been said of the whey-cure applies still more to the grape-cure. Dyspepsia and catarrh of the bowels are constantly the results of the treatment, and a case seldom occurs in which the object could not have been better obtained by means of courses of mineral waters without any of these injurious symptoms."

The best-known resorts for the grape-cure are named below:—

Arco, in the Southern Tyrol, 288 feet above the sea, three-quarters of an hour from Riva, on Lake Garda, and two hours' journey from the Mori station. The season is from October to May, and the place is well suited for cases of consumption.

Bex (see p. 929).

Bozen, in the Tyrol, a town of 10,000 inhabitants, a station on the railway from Munich to Verona. Meran is on the same line.

Dürkheim (p. 929).

Edenkoben, in the Haardt Mountains.

Gleisweiler (p. 951).

Grünberg, in Silesia. **Meran** (p. 797).

Kreuznach (p. 931). **Montreux** (p. 951).

Rheinfelden, in the canton Aargau, Switzerland, at an elevation of 866 feet.

Vevey, canton Vaud, Switzerland; elevation 1263 feet. On the Lake of Geneva.

Any one desiring further details of mineral baths and wells, &c., should consult *Curative Effects of Baths and Waters*, by Dr. Julius Braun, translated by Dr. Hermann Weber, *The Baths and Wells of Europe*, by Dr. John Macpherson, or *The Mineral Waters of Europe*, by Drs. C. R. C. Tichborne and Prosser James.

Section XI.—THE MEDICAL USES OF ELECTRICITY.

The Medical Uses of Electricity.

Electricity has of late years been much employed in the treatment of disease. The benefits derived from it when it is properly employed are in many cases of a very remarkable kind, and for many diseases it affords almost the only hopeful means of treatment. There are now many workers in this department of medicine, and the employment of this agent is becoming yearly more and more extended. Still, the effects of electricity are not well understood, and much remains to be done before this agent, powerful though it undoubtedly is, can become commonly used. It ought to be said that the regular employment of electricity by medical men has nothing in common with the use of magnetic appliances, electropathic belts, and so on, which, so far as is at present known, are entirely valueless. It is the electric current, as generated by the usual forms of batteries, to which reference is made in this section. Two kinds of current are chiefly used: (1) that directly obtained from cells, associated together in the form of a battery, which is a **constant current**, and may be allowed to flow through the part of the body to be acted upon for a certain length of time continuously, or may be interrupted slowly or quickly by a suitable appliance; and (2) that obtained from a coil of wire, in the immediate neighbourhood of another coil through which a current from one or more cells is passing. The first is the ordinary **galvanic current**, or **constant current**; the second is the **induced current**, or the **Faradic current**.

One of the chief purposes for which electricity is used is for stimulating paralysed muscles and nerves. In cases of paralysis from nervous disease, or from lead-poisoning, or from the effect of diphtheria, or in cases of paralysis of a nerve from cold, for example paralysis of one side of the face, treatment by electricity is one of the chief methods of cure. The current from battery or induction-coil is applied directly to the affected muscles or nerves. Holding the handles of the battery or induction-coil so as to permit the elec-

tricity to flow through the body is in no case of much use. The wires from the coil or battery are usually connected with button-like pieces of brass attached to wooden handles, and covered with chamois leather. The leather is soaked in salt water, and the skin over the part to be acted upon is also well moistened with the salt water. These handles with their brass ends are called **electrodes** or **terminals**, and the actual shape and size of the brass piece depends upon the part to which it is to be applied. One electrode is usually placed on an indifferent part of the body, the nape of the neck or some part of the back, and the other is placed over the part to be acted on. The current is then allowed to pass; and if from a battery it may be allowed to flow continuously by keeping the electrodes steadily applied, or it may be interrupted and sent on again by lifting one electrode and then reapplying it. It is when interrupted in this way that the current is most stimulating; and this method of application is employed in paralysis of muscle or nerve. The most stimulating current is the induced current, since it is not a continuous stream but a rapid series of shocks. When a paralysed limb is being treated it is of little use to pass the current through the whole limb at once, but the limb must be gone over bit by bit, each muscle being in turn stimulated to contract, the movement produced being quite visible, and for this purpose anatomical knowledge of the position of the various muscles and the nerves supplying them is of course required.

The stimulating effects of the induced electrical current are made use of in some skin diseases, in some chronic scaly diseases for example. The same effects are brought into play to stimulate the growth of hair on bald patches, such as from the disease of hair known as alopecia areata (p. 329). In such a case one electrode of the kind described, well moistened, is placed on the nape of the neck, and the second is in the shape of a fine wire brush, with which the bald spot is brushed.

Electricity may be employed for the relief of pain, neuralgia for example. For this a weak constant current is used, the electrode connected with the negative pole of a battery is placed, well moistened, over the nape of the neck, and that connected with the positive pole, also well moistened, over the painful spot, and the current allowed to flow steadily for a few minutes. Ovarian pain (p. 507) is thus frequently successfully treated. Painful rheumatic joints may be relieved in a similar way, and sometimes by the induced current applied over the skin of the affected joint by the dry wire brush. The passage of the constant current through a chronic rheumatic joint is often attended by much relief, not only by the soothing effects of the current, but also because it induces beneficial changes in the nutrition of the joint, leading to the renewal of thickenings and swellings.

In hysterical affections electricity employed in association with massage (p. 772) is one of the most important of modern methods of treatment.

Electricity is becoming more and more made use of in nervous affections connected with the brain and spinal cord, and in mental disease, especially in melancholia, there is a great future in store for this method of treatment. The writer has had in his own experience a few very remarkable instances, where complete removal of the mental disorder followed the employment of a weak constant current of electricity to the brain. In such cases, of course, the remedy requires to be very cautiously applied, and could not be ventured upon by any one not well acquainted with the proper method of application.

In surgery the electrical current is made use of for the removal of small tumours and growths. In such cases a current is used sufficient to bring platinum wire to a red heat, the growth being destroyed by being touched with the glowing point, or the tumour being removed by being encircled with the red-hot wire. The advantage of electricity over the ordinary cautery being that the platinum point or wire may be properly adjusted cold, and then the current sent on to make it hot.

In cases of aneurism (p. 244) needles, connected with a battery, are passed into the sac of the aneurism, and the electric current by decomposing the blood in the tumour promotes the formation of a clot.

In eye surgery electricity is made use of to remove pieces of steel from the eye by rendering a steel point magnetic.

These are but a few illustrations of the value of this physical agent in the treatment of disease. Many more might be given. But so much special knowledge is required to enable one to employ such an agent with success and without risk, that no advantage is to be gained from entering into fuller details.

Section XII.—THE USE OF ANIMAL EXTRACTS IN MEDICINE.

Within the last few years great additions have been made to the number of remedies employed in the treatment of disease. In two directions specially valuable progress has been made. One of these is in the employment of preparations made from certain organs or tissues of the lower animals, and the other is in the extension of a process, akin to that of vaccination, by which a person is protected against, or cured of, an infectious disease, by injecting into his body, under the skin, some of the blood obtained from an animal previously made refractory to the particular disease in question.

The former class of remedies is called **animal extracts**, and the latter class **anti-toxins**, and the reason of these terms will be immediately apparent.

Animal Extracts.—Pepsin and pancreatin, described on pp. 845, 846, are animal extracts. They may be extracted, the one from the stomach, the other from the pancreas or sweetbread, of the pig or calf, by soaking pieces of the organ in glycerine or alcohol. They are ferments whose action is understood, and can be carried on outside the body as well as within it. But the new variety of animal extracts, which may be made also by steeping pieces of the desired organ in glycerine, produce their effects only when introduced into the body. Their action is not, so far as is known, due to ferments, it cannot be imitated outside of the body, and their effects are best seen in diseased conditions of the body, when they seem, in a manner not yet understood, to assist some function of the body not being properly carried on. The typical illustration of the use of such extracts is a disease called **myxœdema.** This affection seems to be dependent on disease of the thyroid gland in the neck. In it there is marked increase in the general bulk of the body. The skin is swollen as if it were dropsical, but the swelling is firm and solid, and does not pit on pressure as dropsical swellings do. The skin becomes dry and rough; the face loses its expression; hair falls out, so that the patient becomes bald; the utterance becomes slurring; the quality of the voice altered; movement becomes slow, and also thought; memory defective. The temperature of the body is lowered. These changes go on slowly, so slowly as to take years to become very obvious. In such patients the thyroid gland is diseased or atrophied. The symptoms of the disease may be produced in animals by the removal of this organ. Now, this disease was believed to be incurable, till its relation to the thyroid gland began to be suspected. The first result of this idea was the suggestion of grafting the healthy thyroid gland, just removed from an animal, into the body of the patient, in the hope that if it could be done successfully, the transplanted organ might perform the function the diseased organ had failed to do. Success was obtained. The next step in advance was made when it was found that excellent results followed the administration to the patient, by the mouth, of the fresh thyroid gland of a calf or lamb, finely chopped up. Glycerine extracts were then made use of, and proved of equal value. The gland is now used mainly in the form of tabloids, made of the dried gland compressed. These keep very well, and, swallowed whole, are practically tasteless. In a pronounced case of myxœdema, the effects of the treatment are of a most amazing kind. In a few days the solid swelling begins to diminish with great rapidity, and all the other symptoms to disappear. Even the hair is restored. But the remedy must be given with care, for its effects are sometimes alarming. Nausea, loss of appetite, loss of strength, and indeed great prostration are quite common results if the treatment be carried out too rapidly or too long. But, with care in the administration of the remedy, no evil need be feared. From a quarter to a half of the fresh gland may be given daily, and the dose gradually increased as seems desirable. The tabloids are a very convenient means of administration, at the beginning half a tabloid being given twice or thrice daily, and the dose being gradually increased. After all symptoms of the disease have disappeared the treatment may be stopped for a time, but it is, as a rule, necessary to maintain the condition of health by a short course of the treatment at intervals.

Thyroid extract or tabloids have been found valuable in other disorders. In the disease called cretinism (p. 211) equally remarkable results have been obtained. The remedy has been successfully employed in certain skin diseases, specially psoriasis and lupus, in obesity, and in a very rare disease called **acromegaly**, characterized by the enormous size to which the hands and feet grow. In some forms of in-

sanity benefit of a most remarkable kind has been obtained by thyroid treatment.

Now, these results opened up a new departure in the treatment of disease. The medicinal value of other organs, used raw, or in extract or tabloid, was investigated, and with some result. Before the discovery of the use of thyroid in myxœdema, Brown-Séquard of Paris had advocated the use of certain organic extracts in nervous disorders, and in such diseases ovarian substance and testicular substances, also obtainable in tabloid form, have since been successfully administered.

In certain forms of bloodlessness the use of the red marrow of bone has been suggested and favourably reported on. It also may be obtained in tabloid form, but it is easily procured fresh from the butcher. If one of the short bones of a lamb or calf be split in its length, the red marrow is lifted out by a spoon. It may then be made up with jelly, or, with salt and spice, spread on thin bread and so eaten. Extract of suprarenal capsules, of spleen, of the thymus gland and pituitary body have also been added to the list of remedial agents. From brain tissue, powders called cerebrin and cerebrinin have been prepared, whose value in headache, sleeplessness, and other nervous disturbances is considerable.

Anti-toxins.—In Section XIII. of the first part of this work the relation between living organisms and disease has been pointed out. Some account has also been given of Pasteur's work, and specially in the search of means to combat such diseases. It has been explained, on p. 392, how Pasteur was able to prepare an inoculating fluid which would protect animals against splenic fever. Animals which have thus been protected against an infectious disease are said to be **immune**, and the process is called **immunization.** It is well known how the latest triumph of Pasteur was obtained in the investigation of hydrophobia. From the spinal cord of animals who had suffered from hydrophobia, he was able to prepare a fluid, which, injected under the skin of persons who had been bitten by a mad dog, protected them from this disease. Such a preparation is called an **anti-toxin**, from the Greek words *anti*, against, and *toxikon*, poison. Some years ago Koch, pursuing his investigations into tuberculosis, the disease of which consumption is a variety, due to the action of an organism, the tubercle bacillus, believed he had discovered a remedy for the disease. The remedy was obtained by making a pure cultivation of the tubercle bacillus, and straining off the fluid in which it had been grown. This fluid injected under the skin of tuberculous patients, it was believed by him, would cure the disease. His anticipations have not been fully accomplished, though the preparation thus obtained has, nevertheless, proved to be of great value. It has been found, for instance, that certain marked effects were produced in patients who suffered from any form of tuberculosis, when this substance, called **tuberculin**, was injected, and that they did not follow in the case of persons unaffected by tubercle. The same has been found true in the case of animals. Now tuberculosis is one of the commonest of diseases in cattle, and from cattle it may be communicated to human beings by the use of tuberculous meat, or by the use of milk from tuberculous cows. But often ordinary methods fail to indicate when an animal is tuberculous. The use of Koch's preparation will enable tuberculosis to be discovered in cattle, and so dairy-farmers and stock-raisers have had put into their hands a valuable means of preventing diseased animals being added to their stock.

But though an anti-toxin which shall render a person immune to consumption has not yet been found, success has been achieved in the case of other diseases. The chief instance is that of diphtheria. Why does one attack of an infectious disease protect the patient against a second, or, at least, render the patient much less susceptible? The theory is that the infective organism produces certain substances, in the course of its activity, in the blood and tissues of the patient, which act as poisons to the tissues, but that other substances are also produced, in time, which are antagonistic to these poisonous substances and so arrest their further action. Now if these antagonistic substances could be produced at will, and injected into the body of a person who had been exposed to the particular infection, or was suffering from the disease, the poison of the disease would be antagonized and the patient cured. This is briefly the theory of the anti-toxic treatment of infectious disease. The result has been successfully achieved in the case of diphtheria, the anti-toxin being prepared from the blood of a horse rendered immune. In thousands of cases this remedy has been employed, with the result of a great reduction in the mortality from the disease.

Anti-toxins have also been prepared for erysipelas, tetanus, certain forms of blood-poisoning, and for the poison of snake-bite.

PART IV.

BANDAGING: ACCIDENTS AND EMERGENCIES: FIRST AID TO INJURED: MINOR SURGERY, AND MEDICAL AND SURGICAL APPLIANCES.

SECTION I.—BANDAGING.

The Uses of Bandages:
- *Rules for Bandaging;*
- *The Material for Bandages;*
- *Method of Applying the Bandage.*

Varieties of Turns for the Bandage:
- *The Simple Spiral;*
- *The Reversed Spiral;*
- *The Figure-of-8.*

Bandage for the Hand and Arm.

Bandage for the Fingers and Thumb.

Bandage for the Shoulder:
- *The Spica of the Shoulder.*

Bandage for the Foot and Leg:
- *Bandage for the Heel.*

Bandage for the Groin:
- *The Spica of the Groin.*

To Bandage the Breast and Chest.

The T-shaped, Double-T, Four-tailed, and Many-tailed Bandages·
- *The* T *applied to the Chin and Head.*

Bandages for the Head:
- *The Capelline and Twisted or Knotted Head Bandages;*
- *Simple Bandage for the Head; the Shawl Cap.*

Starch and Plaster of Paris Bandages.

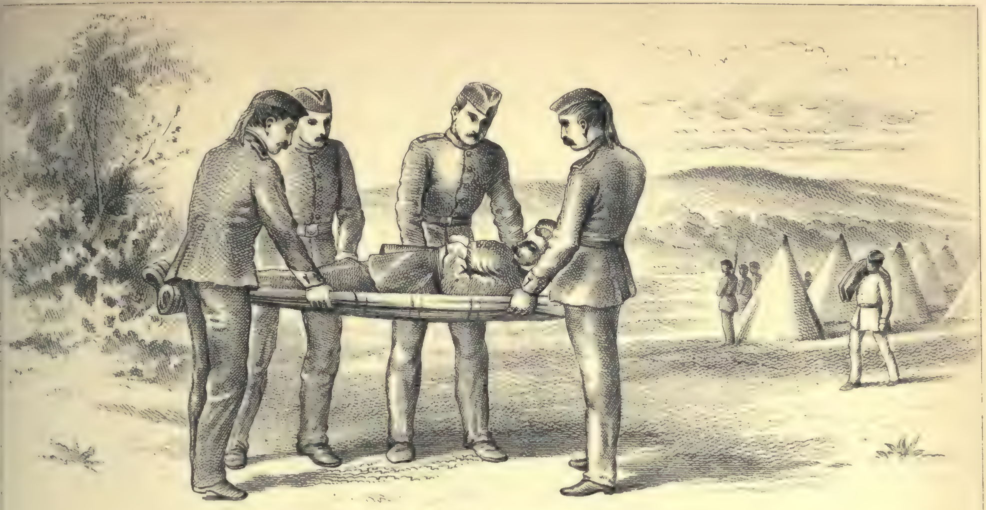
The Triangular Bandage:
- *Its Use as a Sling;*
- *Its Application as a Hand, Arm, Shoulder, Chest, Back, Foot, or Knee Bandage;*
- *Its Application to the Groin.*

The Knotting of Bandages:
- *The Granny and Reef Knots;*
- *The Clove Hitch.*

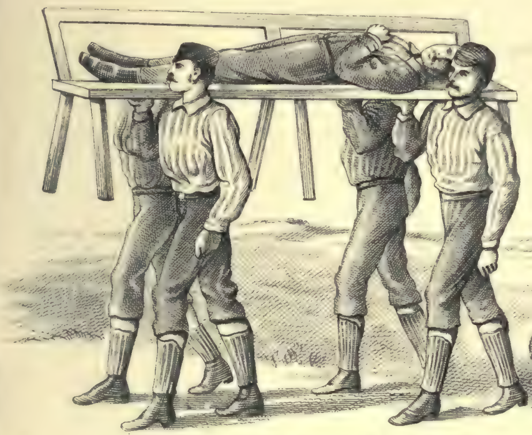
The Uses of Bandages. — Bandages are employed for a variety of purposes. One of their chief uses is to secure dressings or splints. Another is to give support to a limb or to restrain its movements, or to exert pressure upon it to aid in restraining bleeding at some point, or to promote healing as in the case of ulcers, or to aid in the removal of swelling. In these latter cases the bandage must be applied with a considerable degree of tightness, and great care must be exercised that the bandage is evenly put on, and that the tightness with which it is drawn does not give rise to disturbance of the circulation by undue and irregular pressure. This is a point well worthy of particular attention. Suppose the arm is being bandaged from the hand well up over the upper arm. The arteries which carry the blood down the limb are for the most part deeply seated and well protected by muscles, so that they are practically unaffected by any ordinary degree of pressure on the surface. But many of the veins which carry the blood back to the heart up the limb run immediately under the skin, and will be pressed upon considerably by a bandage applied round the arm. Suppose such a bandage applied loosely from the hand up near to the elbow, and suppose when the elbow is approached the bandage is pulled much more tightly, what is certain to be the result? The veins near the elbow will be compressed, the blood will flow less easily along them at that point than it does lower down where the pressure is less. The consequence will be that the blood will be hindered in passing up from the hand; and as blood is all the time being carried

EMERGENCY METHODS OF CARRYING INJURED PERSONS.

Plate XIV



1. Rifles and blanket used as a stretcher



2. Garden seat used as a stretcher

3. Two-handed seat.

4. Three handed seat

5. Four handed seat

6. A method of carrying an injured man upstairs

down to the hand in the arteries, which are unaffected, the veins in the forearm and hand below the tight turns of the bandage will become swollen and gorged with blood. The pressure of blood in the veins will become so great that fluid will be pressed out of the finer vessels into the surrounding tissues, and the hand will become swollen, puffy, and dropsical, while much pain will be experienced. If the tight turns of the bandage are now loosened, the veins will again offer a free passage to the blood, the activity of the circulation will be restored, and the swelling and pain will gradually subside and disappear. Now the results that have been described are exceedingly commonly witnessed as the result of bad bandaging, and it may take days for a hand to recover from the effects of a bandage thus improperly applied. What are the means of preventing such a state of affairs? Bandage loosely, one might say; but a loose bandage may be useless. The proper means of preventing it is to bandage *uniformly*, not to bandage tightly here and loosely there, but to begin with the requisite degree of tightness *at the very extremity of the limb*, and to bandage so evenly and regularly upwards. If any difference is permitted, it should be in the direction of allowing a somewhat less degree of tightness to be given to the turns of the bandage as they pass up. Any required degree of tightness may be given to the turns provided it begins from the extremity. For in such a case the veins are uniformly compressed from below up. They are really made channels of smaller diameter throughout. This does not hinder the return of blood; it simply causes the flow along the narrower channels to be faster than it would have been along the wider ones. But wherever a wide channel suddenly becomes narrowed, then the current becomes impeded and stagnation tends to arise.

Rules for Bandaging.—The first rule then in bandaging a limb is, *Never let the bandage be tighter high up the limb than it is at the extremity; apply it firmly and evenly at the extremity, and let it be carried up uniformly*, if anything allowing it to be a little easier as one proceeds. Now if this be understood, the reason of several rules regularly followed will be apparent. Suppose one has to bandage the upper arm. If a bandage be rolled round the limb simply at the place where it is immediately required, it is plain that the veins at this place will be compressed if the bandage is at all tightly applied, and the forearm and hand will swell. The rule, therefore, is, begin the bandage at the hand and proceed regularly up the limb till the part is reached which one specially desires to cover. We may therefore state as a second rule, that *if a bandage requires to be tightly applied in the course of a limb, the bandage must be begun at the extremity.* Of course if the bandage is to be applied quite loosely it is not necessary to begin at the extremity. It is specially necessary to follow these rules when the bandage is applied to secure a splint, since it must be tight enough to keep the splint in accurate position, or to keep a pad firmly applied over a wound for the arrest of bleeding. A good illustration of the support a properly-applied bandage gives to the circulation is in the case of varicose veins of the leg. The great swelling, dropsy, and pain may be almost entirely removed, at least very greatly relieved, by a bandage being put on with considerable tightness from the toes upwards.

When it is desired to exert very considerable pressure upon a part for a length of time, or when it is desired to keep a limb or a joint motionless for some time, this may be done without the use of splints by stiffening the bandage with starch or plaster of Paris in a way to be described.

The Material for Bandages usually consists of strips of unbleached or bleached calico, linen, flannel, or of muslin, or open web, crinoline or cheese-cloth. Elastic bandages and india-rubber bandages are in use for particular cases. The material should be torn into the strips of the requisite breadth; they should have no hem or edging, as this would prevent them stretching equally in all directions. The strips should be rolled up for use into firm **rollers**. A roller bandage is usually 6 yards long, but may be 8 or 12 yards. They are of different breadths according to the part to which they are to be applied. The commonest size is $2\frac{1}{2}$ and $3\frac{1}{2}$ inches, the former being the size suited for the arms and head, the latter for the legs and groin. For the chest and abdomen a width of $4\frac{1}{2}$ inches is best. For the finger the strip should be $\frac{3}{4}$ in. wide.

Method of Applying the Bandage.—Lay its *outer* side against the part, and let it be unrolled no more than 3 or 4 inches in advance. In the case of bandaging a limb the person should stand opposite the patient and begin on the *inner*, not the outer, side of the limb carrying the bandage from the inner side outwards over the limb.

Varieties of Turns.—There are various methods of making the turns of the bandage so

that they lie smoothly and press equally. The **simple spiral** is that form in which one turn simply overlaps the previous one to about half its breadth. This is the turn with which one very often begins a bandage, but it cannot be carried on very far, because the inequalities of the limb, the rapid thickening of the arm from the wrist upwards, for example, prevent each

Fig. 339.—The Reversed Spiral Bandage.

turn lying closely and evenly over its neighbour. A second kind of turn requires then to be used, called the **reversed spiral**. It is shown in its application to the arm on Fig. 339. As soon as it becomes necessary to make use of the reverse, the thumb of the left hand, which is supporting the limb, is placed on the lower edge of the last turn to fix it. The upper border of the turn is then folded down by turning the roller over in the hand, the roller being held quite slack while this is done. The roller is then carried round the limb till it comes opposite the place where the reverse was made and the manœuvre is repeated. So one reverse after another is made, so long as is necessary. The position of one reverse should be accurately in line with its neighbours as shown in

Fig. 340.—Figure-of-8 Bandage.

the figure; and if the bandaging is well done it looks exceedingly neat and tidy. When the enlargement of the limb is too great to permit even the reverse to lie evenly a third variety of turn is resorted to, the **figure-of-8**. This turn is required to cover joints such as the ankle, elbow, and knee smoothly. It is shown in its application to the elbow in Fig. 340. The bandage is carried alternately up and down the limb; the figure shows it after it has been carried up the limb and is on the point of being brought down. A figure-of-8 loop is actually produced. To do this turn successfully the loops should be made wide, the bandage being carried in a good slope upwards, and then down. When completed the bandage is hardly distinguishable from the ordinary reverse. (Compare Figs. 339 and 340.) Now these varieties of turn may all require to be used in the course of applying one bandage to a limb, the expert using one turn or another as is most suited to the shape of the limb, and producing as a result a firm, well-fitting, and neat-looking piece of work. The figure-of-8 bandage requires twice as much material to cover a limb as the simple spiral, and it is generally limited to turning round joints. When it is desired to cover the heel or elbow alone this is the turn adopted, the end of the bandage being laid over the point of the heel or elbow. The first turn would simply surround the joint, then starting from this the loops would gradually widen out, covering the joint as they proceeded, the loops crossing in front.

Bandage for the Hand and Arm.—A bandage $2\frac{1}{2}$ inches in width is used. Begin by laying the end across the back of the hand, the outer surface being next the skin, carry the bandage round the root of the little finger to the palm, across it, passing between the thumb and forefinger, where it meets and fixes down the end. From here the bandage is carried across the back of the hand upwards to the wrist, round the front of the wrist, and when it reaches the thumb side of the wrist it is carried again across the back of the hand but *downwards* towards the root of the little finger, round to the palm, which it again crosses to the space between the forefinger and thumb, from which it is again carried upwards to the wrist. This is a figure-of-8 turn, and several such turns are taken, each overlapping the other at a proper distance, and the turns being drawn pretty tight, till the palm and back of the hand are covered. It is well to put a little cotton-wool in the palm before the turns are made. Two or three simple spiral turns are then made from the wrist upwards, till it becomes necessary to use the reverse; at the elbow the turn is changed to the figure-of-8, and when it is covered, the simple spiral aided by a few reverses will carry the bandage well up towards the arm-pit. Before the turns are made round the elbow, a little piece of cotton-wool should be placed on the

bend of the elbow and another small piece on the inner edge of the joint, to protect the bony edge. Of course it may not be necessary to carry the bandage farther up than the lower edge of the elbow joint.

Bandage for the Fingers.—For the fingers a bandage ¾ths of an inch broad is required. Lay the outer surface of the bandage on the front of the wrist, carry it once round the wrist

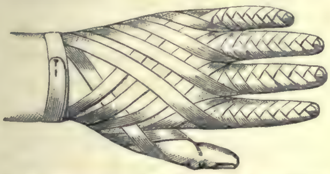


Fig. 341.—Reversed Spiral Bandage for Fingers.

to fix it, passing over the thumb side of the wrist first. When it comes round to this position again, carry the bandage across the back of the hand and right up to the tip of the finger with a few turns. From the tip slowly return down the finger, each turn overlapping the other to the proper extent, reverses being used, till the root of the finger is reached. Then take the bandage across the back of the hand to the wrist and fix it there by one or two turns. If more than one finger requires bandaging, after returning the bandage to the wrist and passing it once round, take it across the back of the hand again to the next finger, and treat it as before. In this way each finger may be bandaged with the same roller. The thumb is treated in a similar manner. This is shown in Fig. 341. One finger is shown in Fig. 342, bandaged with a few simple spiral turns, without any reverse.

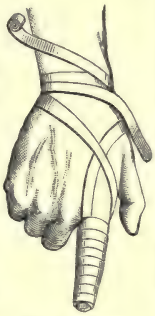


Fig. 342.—Spiral Bandage for Finger.

To bandage the thumb fix the roller by a turn round the wrist, then carry the bandage straight to the tip of the thumb, make one or two turns round the tip, and then descend by reverses to the first knuckle joint. Here the kind of turn is changed in order to cover the ball of the thumb properly. The bandage is carried across the back of the hand, round the wrist, then up round the ball of the thumb, across the back of the hand once more, round the wrist, again up round the ball of the thumb, and again down to the wrist, making a series of figure-of-8 loops, till the whole is covered in. Fig. 343 shows this arrangement, but without showing the tip of the thumb covered. In many cases when it is desired to cover only the ball of the thumb, the bandage to the tip is dispensed with.

Fig. 343.—Figure-of-8 Bandage for Thumb.

Bandage for the Shoulder.—This bandage is called the spica of the shoulder. A few turns of the roller are taken round the upper arm to fix the bandage, which is then carried up in front of the shoulder, over which it passes high up, then across the back to the opposite arm-pit,

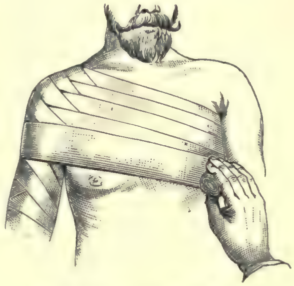


Fig. 344.—Spica of the Shoulder.

where it passes under the arm and over the front of the chest to the top of the shoulder again. Here it is turned down and passed under the arm-pit from which it started, and is brought up in front as at the beginning. Another turn of the course described is taken, and another and another, each turn partially overlapping the one preceding, and each coming lower and lower till the whole shoulder is covered in, when the bandage is finished off by a turn or two round the chest. This, it will be seen, is simply a figure-of-8 bandage. This is the usual method. A little cotton-wool is placed in both arm-pits to avoid chafing by the turns of the bandage. Fig. 344 shows the appearance of the shoulder when the bandage is finished. But in this particular instance the bandaging of the upper arm has been begun from behind, and the bandage has been brought round the outer side of the arm, carried straight across the chest to the opposite arm-pit, carried under it across the back to the top of the shoulder to be covered, then down in front to the arm-pit from which the bandage started, under it and round the back of the arm, and thence across the chest as before.

Bandage for the Foot and Leg.—A 2½-inch roller is used. The foot and leg are bandaged in a way similar to that described for the hand

and arm. Place the end of the bandage on the sole of the foot, carry the bandage up on the inner side of the foot and across the back to the outer side of the ankle, carry it round the ankle, and back across the foot to the outer side at the root of the little toe, down across the sole, and up again on the inner side. This prevents the bandage slipping. Then carry the bandage down the foot with reversed spirals till the heel is reached. There it is carried firmly up the inner side of the instep, and when it reaches the front it is taken round the ankle. The heel is thus not covered in at all. From the ankle the bandage is carried up the leg, by simple spirals up the small of the leg, and then by reversed spirals up the calf, and finished off below the knee-pan (Fig. 345). If the heel is to be covered it may be done by loops of the figure-of-8 turn. When

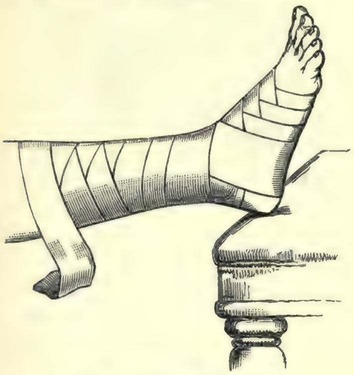


Fig. 345.—Foot and Leg Bandage.

it is necessary to cover the knee the figure-of-8 is also used. The combination of simple spiral and reversed spiral will carry the bandage up the thigh.

To cover the heel only, a broad bandage 3 inches or more is needed. Lay the end of the roller on the front of the ankle, and carry the bandage round the outer side, passing it over the point of the heel, which should accurately rest on the middle of the bandage. Complete the turn by bringing the bandage up the inner side of the heel to the front. The roller is then carried in figure-of-8 loops round the ankle, then across the back of the foot to the outer side of the sole, across it, up on the inner side; and it is then slanted upwards round the ankle again. Each turn half overlaps its neighbour, and thus the bandage passes up the small of the leg on one side and down towards the toes on the other till the whole joint is covered in.

Bandage for the Groin.—A bandage $2\frac{1}{2}$ to 3 inches wide is required. The groin is covered by a series of figure-of-8 loops like the shoulder. The arrangement is called the **spica of the groin.** It is shown in Fig. 346. Two or three turns, simple or reversed, are taken round the top of the thigh, passing from within outwards. The bandage is then carried up to the groin of the same side and outwards round just below the top of the haunch-bone to the back, across the back to the opposite side, and then obliquely downwards in front to the top of the thigh where the bandage began. It is passed round the outer side of that thigh and across the back of it, and is brought up between the legs, and again taken in a sloping direction up the groin, to pass round the back as before. Each turn only partially overlaps its neighbour on its lower side. Care must be taken that the first turn is not carried so high up as to slip off the haunch-bones on to the abdomen. A double spica will cover both groins. For this a very long bandage would be necessary, and when it reached the side of the body opposite to where it started it would be carried down the groin on that side to the inner side of the thigh of the same side of the body, round the back of the thigh, and then up across the body to the side from which it started. The double spica is, however, seldom used.

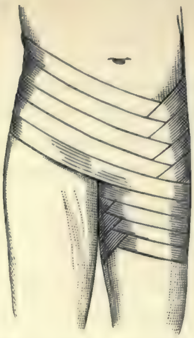


Fig. 346.—Spica of the Groin.

To Bandage the Breast use a 3-inch roller. Begin in front and carry the bandage round the chest below the breasts, passing towards the *sound* side. Two or three turns are made to fix it, and then it is carried upwards in a sloping direction over the lower part of the breast to be covered to the shoulder of the opposite side, over which it is passed. It is then brought across the back to the arm-pit of the affected side, and is carried once round the chest to fix the upward turn by overlapping. When it comes to the front again it is carried upwards again, half overlapping on its upper side the previous upward turn, and passing over the shoulder is again brought to the front by the

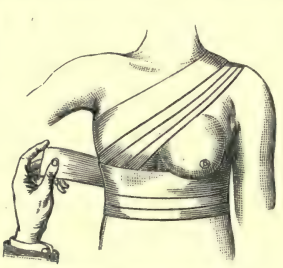


Fig. 347.—Bandage for the Breast.

arm-pit, makes another complete horizontal turn round the chest, and then a third turn is taken over the shoulder. So the process is repeated till the whole breast is covered in (Fig. 347).

The Chest is bandaged by a series of spiral turns from below up; and the bandage is finally carried over the shoulders, like braces, to keep the whole from slipping.

The T Bandage (Fig. 348) is used for fixing dressings close up between the legs. Take a strip of calico 1½ yard long and 3 inches wide. It is used for encircling the body, and is represented by the horizontal part of the **T**. To the centre of it attach a similar strip 1 yard long, in the position of the leg of the **T**. The first portion is placed round the body and fastened in front, the other piece hanging behind is brought up between the legs, fixing the dressings, and is fixed to the front of the encircling band.

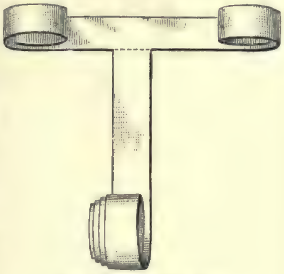


Fig. 348.—The T Bandage.

The Double T is shown in Fig. 349. The encircling band is the same as before. For the limb of the **T** a bandage double the width, or nearly so, is taken and torn up to within 5 inches of one end. This undivided piece is sewed behind to the band that passes round the body, and the two tails are carried up between the legs to the front. It acts like the previous bandage, but is more easily adjusted than the single tail.

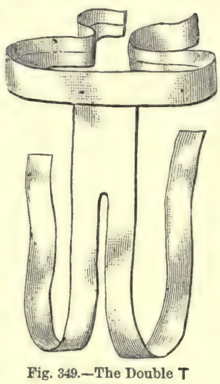


Fig. 349.—The Double T Bandage.

The Four-tailed Bandage is made with a piece of calico 1½ yard long and 6 inches wide. It is torn from each end up to within 3 inches of the centre. Thus there is a centre piece with four tails.

For the Chin this bandage is used by placing the middle of the centre piece on the point of the chin, and carrying the lower tails up the side of the head, tying them on the top, while the upper tails are carried backwards to a little above the nape of the neck and tied there. The ends of the two sets of tails are then tied together to prevent the upper ones from slipping forward on the head, and the lower downwards on the neck. This bandage may be used for the head by placing the centre piece on the top, tying the hinder ends under the chin, and the forward ones at the back of the neck.

The Many-tailed Bandage or Scultetus is shown in Fig. 350. It is used to apply to a limb when, owing to injury, it is extremely undesirable to disturb the limb by lifting, &c., to the extent that is necessary when the roller bandage is passed time after time round the limb. It may be made of an ordinary roller,

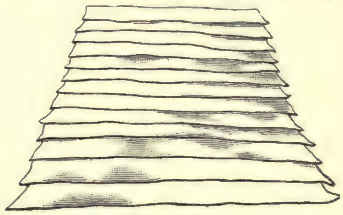


Fig. 350.—The Many-tailed Bandage.

which is cut into lengths sufficient to encircle the limb and leave 3 or 4 inches for overlapping. Thus, suppose it were wanted for the thigh. The measurement of the thigh at the knee, at the middle, and at the top would be taken. Then strips would be taken of those lengths, with an addition of 3 or 4 inches in each case. Other strips would be cut in lengths showing a gradual increase from the one near the knee to the one for the top of the thigh. Of such strips eighteen or more would be required. They are then arranged on a towel. Lay the strip that will encircle the *top* of the thigh down near one end of the towel. Lower down lay the next strip and make it cover the first to a third of its breadth; lay the next one in the same way to cover the lower border of the second, and so on till all the strips are in position one overlapping the other to the appropriate amount. A strip may then be placed right down the centre and fastened to each strip by a stitch, but this is not necessary. The towel may then be folded from one side to another and laid aside till required. When the bandage is to be applied the limb is gently raised, the towel, unfolded with the strips all in position, is slipped under it and properly placed. Then all that is necessary is to begin with the *lowest* strip, bring an end up on each side and overlap them, the ends of the second strip are similarly overlapped, and so on *up the limb;* and when the last strip is folded over and secured, one

ought not to be able to tell the difference between this bandage and one put on in the ordinary way.

Bandages for the Head.—There are several ways of bandaging the head according to the object in view.

The Capelline Bandage (Fig. 351) is used to secure dressings. It requires a two-headed roller, that is, a long bandage 12 yards long and 2 inches wide, rolled up from each end till the

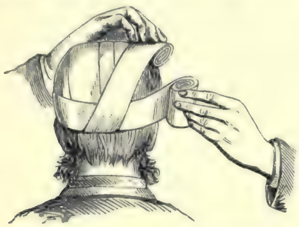


Fig. 351.—The Capelline Bandage.

two rolls meet. The middle of the roller is laid against the forehead, and one end is passed round one side of the head, the other round the other side till they meet low down at the back. Here they are crossed. One end is then continued on its way round the head, the other end is carried up over the top of the head and down to the forehead. Here the roller travelling round the head passes over it to fix it down. It is then turned up and crossed over the head again, this time overlapping one side of the first turn over the head (Fig. 351), and when it reaches the back the travelling roller passes over it to fix it down again. For the third time it is brought over the head, this time overlapping the other side of the middle fold. So on the process is repeated, one roller being carried continuously round the head, the other passing backwards and forwards, now on one side of the middle line, now on the other, till the whole head is covered as shown on Fig. 352.

Fig. 352.—The Capelline Bandage Complete.

The Twisted or Knotted Head Bandage is employed when it is necessary to exert pressure on the artery at the temple to stop bleeding. A two-headed roller, 8 yards long, 2 inches wide, is used. The middle of the roller is laid on the injured temple, and under it is placed a cork inclosed in a double thickness of lint. One end of the bandage is carried round the front just above the eyebrows, the other backwards low down, till they meet at the opposite temple. Here they cross one another. When they meet over the injured part a twist is made exactly over the injury, and one end is carried under the chin, up the other side of the head, and on to the top of the head, where it crosses the other end which has been carried upwards. Both are carried on till they again meet over the injury, where a second twist is made, and the ends then carried round the head and fastened. One twist should exactly lie over the previous one. This may be done in a simpler way with an ordinary roller. Unroll about a foot of the bandage; hold it in one hand near the seat of injury, carry the roller round the head, and when it comes back to the wound give a firm twist with the loose end; then carry the roller under the chin, up the opposite side and over the top of the head, and when the wound is reached repeat the twist. Finally, carry the roller horizontally round the head again, and fix it by knotting the two ends. (See Fig. 353.)

Fig. 353.—Twisted Bandage for Head.

A Simple Bandage to keep a dressing in position on the head needs only an ordinary roller. It is carried horizontally round the head above the eyebrows and low down behind, and, when it is once round, the turn is fastened by a pin. The bandage is then passed obliquely over the head across the dressing, and when it gets down to the horizontal turn it is passed once completely round, thus fixing the oblique portion. A second oblique turn is now made over the head, overlapping the former, and so on. A still simpler method, however, is to use the triangular bandage or a folded handkerchief to make the shawl cap.

The Shawl Cap is a very light bandage for retaining dressings. Fold a handkerchief into a triangular shape, as a shawl is commonly folded. Let the straight edge be applied to the forehead above the eyebrows, and the point lie over the back of the head. Carry the two ends to the back, cross them over the point, and then bring them round to the front and tie them there. Then turn the point up over the crossed ends and fix it with a pin. (See figures in Plate XV.)

Starch Bandages are roller bandages of loose texture, such as crinoline cloth or muslin, which are loaded with a thick starch paste, just before being applied. A thick paste of boiled starch is made, and while it is still hot the roller bandage is unrolled and passed through it, being loosely rolled up as it becomes charged with the starch. Before applying such a bandage to any part of the body, an ordinary roller ought to be put on, and any projecting parts protected with cotton-wool. Then, when the starch bandage is being applied, additional stiffness is secured by rubbing over the turns some of the starch paste. When the whole is complete it is covered in by an ordinary roller. The person on whom the bandage has been put must maintain the position of the bandaged part undisturbed for many hours, to allow the bandage to harden without change. Indeed it is a day or two before such a bandage would be sufficiently hard to enable movement to be made without risk of disturbance. This is the disadvantage of the starch, and herein lies the superiority of the plaster of Paris bandage. Such a bandage might be employed to put up a fractured limb, to keep joints at rest, and to exert continuous pressure over swollen parts.

The Plaster of Paris Bandage is much more useful than the starch bandage. Well-dried plaster of Paris is used. If the plaster has been kept in badly-closed tins, so that it has become damp, it may be dried in an oven with a heat not exceeding 200° or 260° Fahr.; a greater heat would destroy its setting power. A muslin or crinoline cloth roller of coarse open texture is used. As it is gradually unrolled on a table, the dry plaster of Paris is rubbed into it by one person, while another rolls it up loosely, keeping plenty of the powder between the turns. The limb or part of the body to be encased is meanwhile covered in by an ordinary roller, or by a flannel bandage, cotton-wool being placed over any parts requiring protection, and in the case of the foot between the toes. A minute or so before it is to be used, the loaded roller is placed on end in a vessel of water. There should be sufficient water to cover it. It is then applied to the limb or part prepared for it, in the case of a limb being begun at the extremity. The application must be made quickly, the plaster sets so quickly, but at the same time it should be uniform and neat. It is usual to increase the stiffening by making a thick cream with plaster and water, with which the turns of the bandage are smeared as they are rolled round the limb. Usually a couple of bandages 6 yards long are sufficient to produce the requisite degree of stiffness. After the plaster bandages have been applied, a dry roller is put on; the patient remains still, and within half an hour the whole bandage is quite firm. In the case of the leg, the person would be kept still, however, for several hours before movement was permitted, in order to secure perfect hardness and dryness of the plaster. Such bandages are quite commonly applied for fractured limbs, if they can be put on quickly after the accident and before swelling begins. The great advantage of such a method is that within a short time after the application has been made the patient can be transported for any distance without risk of displacement of the ends of the broken bone. They are also very useful for joints which it is desired to keep at rest, in order to permit of the removal of swelling, dropsy, &c. For instance, in the case of swelling of the knee-joint as the result of inflammation or sprain, &c., it is often possible by the use of a plaster bandage to permit the person to go about who, but for the support of the bandage, would be confined to bed or a couch. The employment of this bandage for spinal disease has been illustrated on p. 28.

The Triangular Bandage is of all others the bandage made use of for rendering temporary aid in cases of accident, and is the bandage now familiar almost to everyone, through the training in "First Aid to the Injured" afforded by ambulance associations. It was introduced by the distinguished German surgeon Professor Esmarch, as a means of applying a first dressing on the battle-field. Esmarch's bandages, and

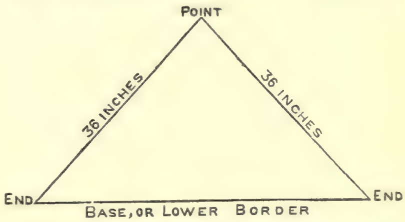


Fig. 354.—The Triangular Bandage.

the bandages supplied by ambulance associations, usually have stamped upon them illustrations of the various uses to which they may be put in securing splints and dressings, in applying pressure to prevent bleeding, in acting as slings to give support to injured arms, and so on. The bandage is made of a square yard of calico or linen halved. Each of the two halves is a triangular bandage, having, of course, two sides 36 inches in length, meeting at the point of the triangle,

and a base considerably longer, fully 50 inches (Fig. 354). The application of this bandage for the securing of temporary splints in cases of fracture is described in the third section, and its use for controlling bleeding from injuries is illustrated in the next section; but a few of its other uses will be pointed out here.

The Triangular Bandage as a Sling is illustrated in Plate XV. The bandage is laid, unfolded, across the body, one end passing over the shoulder opposite to the injured arm, the other end hanging down, and the point projecting out beyond the elbow of the injured arm. The arm to be bandaged is bent at the elbow, and carried over the chest, the hand being held higher than the elbow. The hanging end of the bandage is now brought up over the forearm and round the root of the neck on the same side, being tied with the end which passed over the opposite shoulder. The point is then brought neatly round the elbow and secured with a pin in front. (See Plate XV.) Such a bandage, when properly applied, carries the weight of the arm and relieves the shoulder. Sometimes only the hand and wrist are supported, the weight about the elbow being unsupported, as in cases of broken upper arm-bone, when the weight is needed to keep the upper arm on the stretch and prevent the broken ends of bone from riding on one another. In such a case the **small arm sling** is applied. (See Plate XV.) This is done by folding the bandage into a cravat-form, by folding the point down to the base and folding again so that a proper breadth is secured. The two ends are then passed round the two sides of the neck and secured as shown in the plate.

The Triangular Bandage for the Hand.—Spread out the bandage fully; lay the hand flat upon it palm downwards, the wrist resting on the base or lower border, the fingers directed to the point. Bring the point of the bandage over the fingers and back of the hand and let it pass over the wrist up the back of the forearm. Bring the two ends round the wrist, securing the point, cross them and carry them round to the front of the wrist, cross them again, bringing them to the back of the wrist, and tie them there. The point may be folded down over the crossing of the ends, on to the back of the hand, and fixed there with a safety-pin. The hand bandaged is shown in Plate XV.

The Triangular Bandage for the Arm.—Fold the triangular bandage into a broad bandage by folding the point down to the base or lower border, and then folding into two. Place the centre of this over the part to be covered, carry the ends round the arm, cross them, and carry them back again; let them be crossed again and carried round once more to the opposite side, where they are tied.

The Triangular Bandage for the Elbow.—Lay the centre of the bandage over the back of the elbow-joint, its lower border or base crossing the back of the forearm, its point passing up the back of the upper arm. Take the ends round in front, cross them, carry them to the back above the joint, and tie them there. Then fold down the point over the ends and secure it with a pin.

The Triangular Bandage for the Shoulder.—Spread the bandage out over the injured shoulder, its centre over the point of the shoulder, its point passing up the neck, its base or lower border resting over the middle of the upper arm. Pass the ends round the arm, cross them, bring them to the front and tie them there. Take a second triangular bandage, fold it into the small arm sling, and with it support the forearm. Let this sling pass over the part of the shoulder bandage that reaches up to the neck. Fold down the point of the shoulder bandage over the sling, and secure it with a safety-pin. This arrangement is shown in Plate XV.

Another way of bandaging the shoulder, when it is unnecessary to support the forearm, is to fold a second triangular bandage into a narrow bandage and carry it over the injured shoulder across the body and under the opposite arm-pit, the ends being pinned at the back and the front. The point of the shoulder bandage is then folded over this and pinned as in the former case.

A *single* triangular bandage may also be used to secure dressings, hot fomentations, poultices on an injured shoulder, in the following way. Let the centre of the fully unfolded bandage be placed over the shoulder as before, its point passing up the neck; carry the ends round the arm to the arm-pit, cross them there, and then take one end up in front of the shoulder, another up behind, and tie them, or pin them, over the top of the shoulder, then fold down the point over the ends and fasten it.

The Triangular Bandage for the Chest.—Spread the bandage out over the injured side, with its centre over that side; carry the point over the shoulder of that side, carry the two ends round the waist, knotting them there, one end being left long. To this end tie the point which has passed over the shoulder (Figs. 355, 356). The knots should be so placed to one side

that they are not pressed upon when the patient lies down.

The Triangular Bandage for the Back is applied similarly to that for the chest, only the

Fig. 355.—Front View.

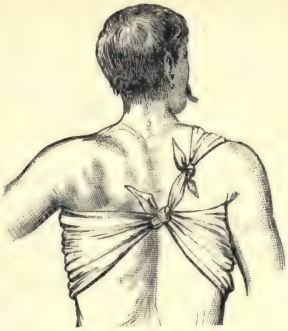


Fig. 356.—Back View

The Triangular Bandage applied to the Chest.

bandage is spread out over the back, the point passing over one shoulder and the ends round the waist to be knotted in front. This is an excellent method of fastening on poultices, dressings, &c. Where knots are undesirable the ends should be secured by safety-pins.

The Triangular Bandage for the Foot.—Spread out the bandage and lay the foot flat on it so that the end of the big toe is about the centre, the toes directed towards the point. Fold the point down over the toes and back of the foot, letting it pass up the front of the ankle. Bring the ends over the back of the foot, cross them, carry them round to the back of the ankle, cross them there, and bring them round to the front of the ankle, where they are tied. The point may then be folded down over the ends.

The Triangular Bandage for the Knee is similar to that for the elbow. The centre of the bandage is placed over the joint, the point directed upwards. The ends are carried behind, crossed; brought round to the front and tied, and the point is folded down over the knot and pinned.

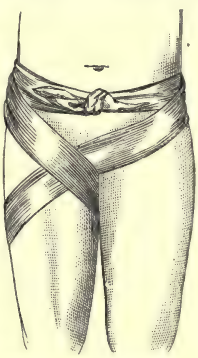


Fig. 357.—The Triangular Bandage applied to the Groin.

The Triangular Bandage applied to the Groin.—The triangular bandage may be used to fix dressings on the groin by folding it into a narrow bandage. To do this spread out the bandage, bring the point down to the middle of the base, then fold into three. Place the middle of this narrow bandage close up between the two legs, carry one end up in front along the groin, carry the other end up behind along the fold of the buttocks, cross them on the outside of the hip, and then carry the ends round the haunches, to tie them on the opposite side, or if the bandage be long enough continue the ends to the front and tie them there (Fig. 357).

The buttocks require two triangular bandages. One is folded into a narrow bandage and tied right round the body as a belt, always low enough to be over the haunch-bones. A second bandage is spread out so that its point passes up on the outer side of the buttock to be covered. The point is passed up under the belt and then folded down over it, to be pinned there. The middle of the base or lower border of the bandage should reach down below the lower edge of the fold of the buttocks. The ends are carried round, one over the front of the thigh, the other behind, and are tied or pinned (Fig. 358).

Fig. 358.—Triangular Bandage applied to the Buttocks.

The Triangular Bandage for the Head is applied in the form of the shawl cap, as described on p. 960, and illustrated in Plate XV.

The Knotting of Bandages.—The knot which is commonly made is familiarly called the **granny knot**. The direction which the

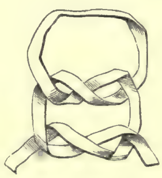


Fig. 359.—Granny Knot.

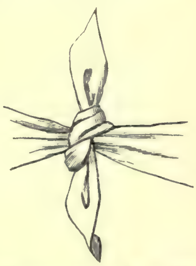


Fig. 360.—Granny Knot tight.

ends take is shown in Fig. 359, and the appearance of the knot when drawn tight on a bandage is illustrated in Fig. 360; the ends

set *across* the direction of the bandage. This knot should never be used for surgical purposes. The thread, tape, or bandage so tied is seldom secure, and always liable to slip. It is in surgery usually of the utmost consequence that the possibility of slipping should be entirely discounted, especially when the firmness of dressings over a wound or the stoppage of bleeding is dependent upon the knot being secure. In all such cases the **reef-knot** should be employed (Fig. 361). It will be noticed that in both cases the first turn is the same. When this has been made, if the loose end opposite the person's right hand be carried across and held in the left hand while the other end is taken first *under* it and then over it, the ends will be in the position shown in Fig. 361. In the case of the granny knot the second end is taken *over* the first and then under it. When the ends of a bandage are tied in a reef-knot, and the knot pulled tight, the appearance of the knot is as shown

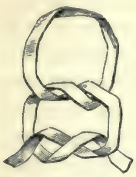


Fig. 361.—Reef-knot.

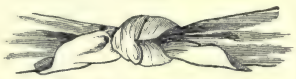


Fig. 362.—Reef-knot tight.

in Fig. 362; the ends set *in line with* the direction of the bandage.

The **clove-hitch** is used for fastening a bandage or towel round a limb in order to give good hold for a firm pull. Fig. 363 shows how it is made. The bandage is caused to make two turns or bends on itself, as shown. The second bend, that to the right in the figure, is then placed behind the first, and through the space formed by the opposite halves of the two, and marked + in the figure, the limb is placed. Fig. 364 shows the hand passed through and the ends of the clove-hitch hanging from the wrist. The two ends, being taken hold of, afford an excellent means by which the arm may be strongly pulled on. The more strongly one pulls the tighter does the noose become, and there is no possibility of it slipping, while it may be unloosed, if needful, in a moment. In a case of dislocation at the shoulder-joint, for example, the clove-hitch

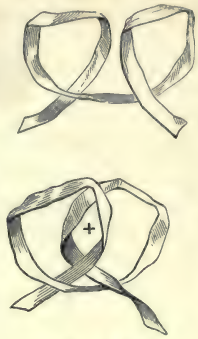


Fig. 363.—Clove-hitch.

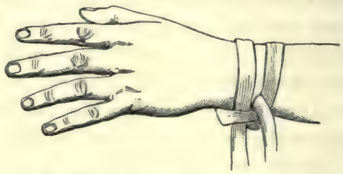


Fig. 364.—Clove-hitch applied to Wrist.

would be applied round above the elbow-joint, and thus the lower end of the dislocated bone would be directly pulled on in the effort to reduce the displacement.

SECTION II.

THE TREATMENT OF WOUNDS AND BRUISES. THE ARREST OF BLEEDING. POISONED WOUNDS, SNAKE BITES, AND INSECT STINGS.

Wounds and Bruises and their Treatment.

Varieties of Wounds:
Incised, Punctured, Lacerated, and Contused Wounds.
The Repair of Wounds:
Healing by Immediate Union;
Healing by First Intention—Scar or Cicatrix;
Healing by Second Intention or Granulation—Healthy Pus.
The General Treatment of Wounds:
The Stoppage of Bleeding;
Cleaning the Wound;
The Closing of the Wound—The Use of Strapping and Sutures;
The Protection of the Wound—Dressings and Bandaging.
The Re-dressing of Wounds.
The Treatment of Incised or Clean-cut Wounds.
The Treatment of Punctured, Bruised, and Lacerated Wounds.
The Treatment of Wounds of the Scalp.
The Treatment of Bruises or Contusions—Ecchymosis—How to Treat a Black Eye.

The Arrest of Bleeding.

The Distinction between Bleeding from an Artery, a Vein, and Capillary Vessels.
The Methods of Stopping Bleeding:
Elevation of the Wounded Part;
The Application of Cold and Astringent Substances—Styptics;
The Application of Pressure;
To Arrest Capillary Bleeding;
To Arrest Bleeding from a Vein;
To Arrest Arterial Bleeding—Methods of arresting bleeding from the arm and hand, foot and leg, head and neck, nose;
Tourniquets and how to apply them to stop bleeding;
Artery Pressure or Catch Forceps.

Poisoned Wounds; Insect Stings; Snake Bites; and other Kinds of Poisoned Wounds.

Poisoned Wounds and their Treatment.
Stings and Bites of Insects and other Animals:
Bees' and Wasps' Sting and its Treatment;
The Mosquito Bite;
The Chigoe or Jigger;
Ticks; Bed-bugs; Spiders—The Tarantula;
The Scorpion and Centipede;
The Guinea-worm.
Snake Bites:
Non-poisonous Snakes—The Common Snake, the Black Snake, the Anaconda, Pythons, and Boa.
Venomous Snakes—The Viper and Rattlesnake, the Water Viper or Moccasin, the Copper-head and Cotton-mouth, the Harlequin-snake, the Jararaca, the Tiger-snake and Death Adder, the Horned Snake and Puff Adder, the Asp, the Cobra, Bungarus, Russell's Viper and Ophiophagus Elaps.
The Treatment of Snake-bite.
The Poison of Venereal Disease:
Gonorrhœa, Bubo, &c.

WOUNDS AND BRUISES AND THEIR TREATMENT.

Varieties of Wounds.—Wounds are commonly divided into four classes: (1) **incised wounds,** inflicted by sharp instruments, so that the wound is clean cut; (2) **punctured wounds,** wounds caused by narrow instruments being forced into the body, including stabs, pricks,

&c.; (3) **lacerated wounds,** which are of the nature of tears; and (4) **contused wounds,** which are caused by falls or blunt instruments, and in which the parts about the wound are bruised. These distinctions are of importance even from a popular point of view. There are, comparatively speaking, few people who are unfortunate enough to get a bone broken, but almost no one, if any one, escapes a wound of one kind or another. Everyone ought to know, in a general way, how to treat the ordinary kind of wound, of which every household has more or less experience, and a knowledge of the distinctions between the different kinds of wounds enables one to perceive very easily the appropriate means of dealing with each as it arises. In the simple clean-cut wound, for example, there is practically no destruction, no death of parts. Supposing the instrument to have been clean and the wound clean, setting aside for the moment the question of bleeding, there is little needed, it is plain, but the accurate bringing together of the divided parts to secure the closure and healing of the wound. On the other hand, in the case of the contused wounds, or wounds accompanied by bruising, there is destruction more or less severe and more or less extensive of some of the wounded tissue. The vitality of the parts has been lowered, their power of repair seriously diminished, and of some portions of them completely abolished. It is evident that the attempt to close such a wound, as one would a clean-cut wound, is doomed to failure, for the parts that have been destroyed, however small, must come away before healing can occur. When the bruising has not been severe enough actually to destroy any of the tissue, it may be that by appropriate methods, by careful nursing of the wound, so to speak, the diminished vitality may gradually be restored to full activity and all the tissue saved. But to adopt the methods proper for keeping close together the cut surfaces of the clean-cut wound might be to ensure the death of the parts in a bruised wound. A torn wound is in something of the same position. If the parts have not been pressed upon, as in the bruise, they have been violently torn apart, and the strain upon the tissue must have seriously lowered its vitality and power of repair. Then the punctured wound will partake more or less of the character of the clean-cut wound, if it has been inflicted by a sharp-pointed and sharp-edged instrument, or of a bruised wound if the instrument has been blunt-pointed, or, while sharp in the point, is thick and blunt beyond it, as, for example, a steel for sharpening knives; or the punctured wound may be also of the nature of a tear. But one special point to be remembered about it, whatever its character, is that it is deep out of all proportion to the extent of wound shown on the surface, that if the instrument were dirty, some of the dirt may be lodged in the depth of the wound, beyond the reach of sight, or some fragment of clothing or other material may have been carried in with the point of the instrument, or, for that matter, some portion of the instrument which did the damage may have broken off in the depth of the wound and be lying there.

Now many people who read these sentences will be inclined to say, "Oh, well, really, these are fine points for a surgeon to consider, which the ordinary man or woman cannot be expected to take into account." But this is not, in any sense, true. They are most important points, but they are not "fine points" nor "difficult points." They need the exercise of nothing more, or little more, than ordinary common sense. So long as cut fingers, and broken knees, and bumped heads are the common incidents of a household—so long as wounds and bruises are the everyday occurrences of a workshop—so long as every mother thinks that she is quite fit to attend to the ordinary run of these things herself, and every workman that he can "doctor" any ordinary small affair himself, so long should every man and woman think it necessary to look at the simple common sense of the matter, and be ready to apply it when necessary. Therefore let us look for a minute at the two ways of regarding even the minor wounds and accidents which everyone thinks he can treat "just as well as the doctor." The one way is to regard its mere size, and if it does not look big, and there is nothing terrifying in its aspect, and no bleeding worth talking about, to cover it up with a rag or stick a piece of plaster on it, and expect it to heal without further trouble. And of course, in nine cases out of ten they do heal, because nature is fit for the most of the demands made upon her reparative powers. But perhaps the tenth case goes wrong, and, as likely as not, the injury seemed at first of the most trivial kind. Nevertheless, owing to the want of observing a little common sense, and after many days, the doctor is, perforce, appealed to, because the slight cut, or the small bruise, or the prick that was hardly worth talking of, has become a large, deep, foul sore, which refuses to heal, and gives much pain and general disturbance. Now what we have

called the common-sense way of looking at even a trifling injury is followed, when the person asks himself the question, What kind of a wound is it? is it a clean-cut wound which should heal easily, or is there much damage to the parts which may cause it to heal with greater difficulty? secondly, when the person asks the question, What did it? the answer to which will probably indicate whether any foreign material has been carried into the wound, likely to lead to an interference with its quick healing; and thirdly, when the person gets, if possible, the object which caused the wound, still further to settle the second point, and to make certain that, if it was material likely to break, no part has been left in the wound. It does not need much, if any, special skill to determine these points, and when they are determined anyone will be in the position to decide with tolerable accuracy whether the wound is as trifling as it looks, and whether simple and unskilled treatment will be sufficient. For it must never be forgotten that the smallest possible wound may occasion the greatest possible trouble, if by it there gain entrance to the body any foul or putrefying material capable of propagating itself in the tissues, and that tissues of lower vitality, and consequently diminished resisting power, will offer to it a most suitable lodgment.

If, then, one remembers the four different kinds of wounds, little difficulty will be experienced in deciding, regarding the ordinary run of simple injuries, which of them are the more serious, and what are the special things to be attended to in dealing with them.

The Repair of Wounds.—The clean-cut wounds show the simplest and most rapid method of repair when they heal by what is called **immediate union.** In this case the surfaces of the wound are brought accurately together throughout their whole extent; they adhere closely, and after the lapse of a few days they have become reunited, and are continuous, the circulation being completely re-established, *no scar being left* to indicate where the wound was. This is a mode of healing that does not very often occur, and can take place only under the most favourable circumstances. It is evident that it cannot occur unless every portion of the divided parts, and not the *edges* of the wound only, are accurately and firmly replaced in their original situation. This cannot be done if streaks and clots of blood are allowed to remain in the wound, or if bleeding goes on after the wound has been closed, or if particles of dirt are left in it; nor can it occur if matter forms; nor is it at all likely to take place if any time has elapsed since the wound was produced, so that the two surfaces of the wound have become coated with a film of coagulated material. In all other methods of repair new material is formed to fill up the breach which the wound has caused. This new material is not produced from the blood clot which may fill the wound. It seems to be produced from two sources. In describing the structure of the blood, on p. 213, the white cells of the blood, or white blood corpuscles, or leucocytes, have been spoken of, and it has been explained on p. 214 how these cells are capable of passing through the walls of the fine blood-vessels and wandering through the tissues. Now if a small piece of the material which is filling up a healing wound be examined under the microscope it is found to consist of a mass of such white cells, and the belief is that soon after the wound has been produced white cells from the neighbouring vessels find their way to the seat of injury, and there multiply in enormous numbers, affording thus the material for repair. This is not a mere fancy nor bit of imagination; the process can be witnessed going on under the microscope. The passing of the white blood corpuscles from the fine capillary vessels may be watched in the web of a frog's foot, viewed under the microscope, if the surface of the web be irritated in

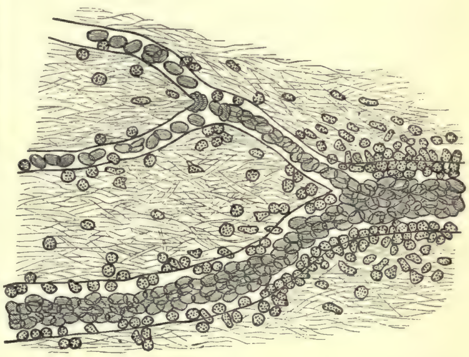


Fig. 365.—The appearance under the microscope of a minute piece of fine tissue which has been irritated. A blood-vessel is shown branching. The red corpuscles are seen streaming down the centre of the vessel, the white corpuscles are rolling along the walls of the vessel, adhering to them, and passing out of the vessel in great numbers, and finding their way in the direction of the seat of injury.

some way. The appearance under the microscope is shown in Fig. 365. Every tissue, skin, muscle, nerve, bone, &c., contains a certain amount of connective tissue (see p. 16). One of the elements of connective tissue is cells, which, in the opinion of some, are capable of

multiplication, so that some of the new growth formed to fill up a wound may be derived from the cells of the connective tissue of the part. Suppose then a clean-cut wound, and the edges brought together. The two cut surfaces are not absolutely united, a fine probe could readily be insinuated between them, just after they have been brought together. But in twenty-four hours this is no longer so, the fine gap is filled up and the edges of the wound are glued together. Of course a little violence would still separate them; but the difference between the state of the wound now and its condition twenty-four hours before is marked. What is the cause of this? The gap is filled up by cells held together by material which has oozed from the blood-vessels, of a fibrinous nature, which "sets," so to speak, and thus glues both sides of the wound together with the cells into one closely coherent mass. The cells undergo rapid change of form; from round cells they become spindle-shaped, and in the course of a few more days the wound is united by a wedge of new tissue of a fibrous character, which condenses and becomes firmer, and into which an extension of blood-vessels takes place from surrounding parts, so that by and by the position of the wound is only indicated by a fine white line, or scar, or **cicatrix**, the edge of the new slice of tissue which nature has introduced to unite the separated surfaces. A wound which unites in this way is said to heal "**by first intention.**" This is the kind of union one seeks to bring about; there is no loss of substance, no matter is produced, and there is no interruption to the healing process. For such union it is necessary that there be no blood left in the wound, or dirt of any kind, since either would interfere with the healing process by leading to the formation of matter which would require to be expelled. Then healing by first intention cannot occur in a wound accompanied to any extent by bruising, for particles of the tissue are in such a case destroyed, and will be sooner or later separated from the living healthy tissue.

In wounds where there is any loss of substance, any destruction of particles of the tissue, healing takes place by what is called **granulation**, or by **second intention.** In the case of a wound on the surface, say a bruised wound, there is a discharge from the surface, a thin yellowish-red discharge, consisting partly of fluid oozing from the wound and partly of the dead particles of tissue. In the course of a few days the wound has become an open sore, with a more or less even surface considerably below the level of the skin. After all particles of dead tissue have been removed the surface of the wound should be uniformly clean and red. If it be carefully examined it will be seen that the surface is not glazed and smooth, but is covered all over with fine red granules projecting from the surface. These are called **granulations.** They are formed by masses of the round cells already spoken of, and fine loops of blood-vessels project up from the sound tissue below into the granulations. They are, in a healthy wound, fairly firm, but any rough handling will make them bleed. They grow rapidly, coalescing with their neighbours, and as this goes on the wound gradually becomes shallower, gets filled up, and approaches the level of the surface. The material thus formed is really the same as that which united the opposed surfaces of the closed wound. During this process matter is continually being separated from the surface, of a creamy thickness and pure yellow, and without smell, if the wound has been kept clean. This matter is called **pus**, healthy pus, and if it be examined under the microscope it is seen to consist of round cells; in fact of cells similar to the wandering cells spoken of, and which come from rapidly-multiplying cells of the granulations. When the gap caused by the wound has been filled up and the granulations reach the level of the skin, the surrounding skin begins to advance inwards. A pink border surrounding the wound indicates the activity of the circulation going on to aid growth, the pink border thinning away towards the wound. Day by day the size of the wound is seen to be lessened, until it is wholly covered by a scar, formation of matter having ceased. In the deep parts of the new tissue condensing changes occur, which also extend to the surface, and this shrinkage goes on for a prolonged period till the size of the scar or cicatrix is ultimately very much smaller than that of the original wound.

When the granulations receive too great a supply of blood, they become excessively large and flabby, and soft, not firm as they should be. They are said to be exuberant. In such circumstances they sprout beyond the level of the skin, and are popularly called "proud flesh." It is common to reduce them by the use of caustic. This is a mistake. Firm pressure with a pad and bandage will usually restrain them sufficiently to enable healing to go on to a satisfactory termination.

When healing takes place under a scab it very much resembles that which occurs in the healing by first intention. But, owing to the

presence of irritating material, matter may form under the scab, and its confinement might lead to extensive destruction of parts and the production of a deep sore. This, however, would be indicated by pain, inflammation, and a soft boggy feeling of the part. When, however, the wound and its scab are firm and dry, and there is little redness or tenderness, one may be assured that the healing process is going on satisfactorily, and when the wound is finally closed the scab will become readily detached. The scab is, in short, nature's method of closing the wound to prevent the entrance of disturbing elements from the outside, and of protecting the part till the breach has been repaired.

Now it must not be supposed that it is only in exposed wounds, in wounds on the surface of the body, that such methods of repair are found. Injuries in the deep parts are repaired in precisely similar ways. Bone is repaired in a similar way: the new tissue, which in the skin takes on the resemblance to skin, in bone comes in time to resemble bone, knitting its broken ends firmly together. Muscle is repaired in a similar way, so also is nerve. If a divided nerve be accurately united the new tissue formed at the place of union will in time take on the form of nerve tissue, and the function of the nerve may be restored.

The General Treatment of Wounds.—It will be clear from what has been said that the treatment of wounds will vary to some extent with the nature of the wound. While that is so, there are certain general rules to be followed with any or every wound. Let us see first of all what these are, and then we can consider what changes are required to meet the different kinds of wounds. The rules are these:—

I. Stop bleeding.
II. Cleanse the wound and remove all dirt and other foreign material.
III. Restore the parts, as nearly as possible, to their proper positions, diminishing gaping as much as possible.
IV. Secure complete rest to the part, and protect it from outside influences, but take care to prevent the accumulation on or in the wound of any discharge.

I. As to the arrest of bleeding, the proper methods of doing so will be considered later in this section. A very large number of the ordinary wounds, however, give little trouble in this respect. It is only when an artery has been cut, or a vein of some size, that bleeding is troublesome enough to tax the resources of the layman. Raising the part, the use of cold water, pressing on the wound itself with a piece of clean lint, will usually be sufficient to stop the welling up of blood from the ordinary wound. One thing must not be done: cloth after cloth, handkerchief after handkerchief, must not be piled on the wound, and then the whole part enveloped in some ample dressing. If an artery or large vein has been wounded, it is highly improbable that the bleeding will thereby be made to cease. It will only continue, *without being seen*, till the whole mass of covering has been soaked through. No one must delude himself with the belief that bleeding is stopped *because it is hid*. This is akin to the fatal policy of the ostrich, which hides its head in the sand, in the delusion that the hunter will not see it because it does not see him. Nor is it advisable to pour on the wound substances like friars' balsam, or steel drops, or other discolouring and sticky substances to arrest the bleeding. No attempt should be made to bring the surfaces of the wound together or to dress it till bleeding has ceased. Often when no large vessel is wounded there is a very considerable flow of blood from the fine capillary vessels, which does not readily stcp. For this the use of an iodine lotion is recommended, 20 drops tincture of iodine in an ounce of warm water, or, roughly, as many drops of the tincture in a basin of warm water as will make the water of a light sherry colour. A sponge, or, preferably, a piece of clean lint wrung out of this lotion and pressed on the wound for a minute will usually be sufficient. It is besides a useful lotion for cleaning the wound.

II. The cleaning of the wound and the arrest of bleeding will often go together. Even though the cleansing of the wound starts the bleeding afresh for a little, it must be done, since to permit a mass of blood clot, dirt, &c., to remain in and around the wound is only to encourage decomposition and the production of a foul-smelling sore and to delay the healing process. But the cleaning process should not be roughly done. A gentle stream of water, tepid or cold, is caused to play on and about the wound; and gradually clots and foreign material will be washed away. Small pieces of surgeon's lint may be used, well wetted, gently to wipe the wound, and assist in the removal of clots, &c. The water should contain some antiseptic material, if it is at hand, such as carbolic acid, 1 ounce to 2 pints of water, or the iodine lotion already mentioned. When the wound and surrounding parts are thoroughly clean, it should be carefully examined

to see that no foreign material lurks in its corners or is embedded somewhere in it. As already mentioned a knowledge of what caused the wound will help in determining whether any splinter of material is likely to be buried in it. If so, it must be searched for and removed, otherwise suppuration will ensue, and the wound will refuse to close till it has been removed.

III. The restoration of separated parts to their original position is easily accomplished in clean-cut wounds, and is the proper thing to do, since it promotes their speedy union. But in torn and bruised wounds accurate replacement is needless, since some of the tissue is certain to break down and be separated, either in pieces, which are called **sloughs,** or in the form of discharge. Still the chance of their reuniting should be taken advantage of, though not to the same extent as in the clean-cut wounds, and care must be taken to provide for the escape of any discharge or separated particles. The surfaces of the clean-cut wound are brought together either by strips of adhesive plaster, by sutures, or stitches. It must not be forgotten, however, that the edges, the surface, of the clean-cut wound may be brought together and the deep parts may gape. Fluid and blood may, therefore, ooze between the deep parts of the wound, separating them farther, while the external edges are uniting. Thus a collection of matter may form in the depth of the wound, bursting open the united edges sooner or later, and causing pain and swelling before that occurs. In every clean-cut wound of any depth, therefore, surgeons as a rule try to unite the divided surfaces by the passing of sutures or stitches from one side of the wound, through its depth, to the other side, and further aid in keeping the parts together by carefully-adjusted pads at a little distance from each side of the wound. In shallow wounds strips of plaster may do all that is necessary. But in exposed parts, where it is desirable to have as little scar as possible, as on the face, even shallow wounds are stitched together. The sutures are usually of silver wire, or of catgut or silkworm gut, usually soaked in carbolized oil, appropriate needles being employed. In shallow wounds black silk thread, well waxed with bees'-wax, introduced by fine sewing needles—No. 9—suit excellently. The use of carbolized catgut or silkworm gut is now very extensive in surgery, because it does not require removal after the wound has healed. The part buried in the tissues becomes gradually softened and absorbed, and the external ends then drop away. The ordinary adhesive strapping, or lead plaster, is in common use for closing a clean-cut wound. It should be cut in strips of about a quarter of an inch in breadth and of sufficient length to extend a considerable distance on each side of the wound in order to have a sufficient surface of support. The plaster is warmed all over its surface by heating before a fire or over a gas flame, and is fixed on one side of the wound. Then while the finger and thumb of the left hand keep the edges of the wound accurately together, the right hand carries the strip over to the other side. The plaster is smoothed down close over the skin and held for a few seconds till it has secured a firm hold. If the wound or skin be wet, the plaster will of course not adhere at all. A method of applying the strips to avoid "cockling" is shown in Fig. 366. Two strips are used,

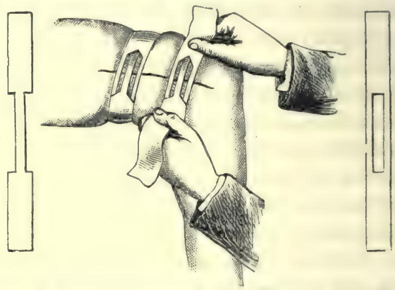


Fig. 366.—A Method of applying Strips of Plaster to close a Wound.

cut as shown in the figure; one is applied on one side of the wound, and the other on the other side. The end of one strip is then passed through the slit in the centre of the other, and then an even pull on both ends accurately closes the wound. The strapping should never completely cover the wound. Intervals should be left between each strip, and the corners of the wound should not be strapped, that an opening may be left for the escape of any oozed fluid.

It has been said that it is undesirable to attempt to close bruised or lacerated wounds, since the death of some part of the tissue is almost certain. As a rule, that is to say, sutures or strapping are not employed to bring the separated surfaces together, though parts are replaced, after being cleansed, as nearly as possible in their proper positions. In the case of punctured wounds, however, the external opening of the wound is kept open, instead of its union being promoted, in order to ensure the escape of any discharge or oozing of blood, &c., from the depth of the wound. It is not till the lapse of a few days, when all risk has passed away, that the opening is allowed to close.

IV. The protection of the wound from dis-

turbances of various kinds is one of the chief means of promoting its healing. One of the most important ways of securing this is by rest, complete rest of the part involved. Suppose a cut extends across the wrist, nothing could be more hurtful, or could more seriously delay healing, than the use of the hand in any occupation whatever. Many people think if the part has had some dressing applied and is bandaged, it should be sufficiently supported, and that they ought to be able to go about their ordinary duties. If it does not unite rapidly, and if it shows signs of inflammatory action along the edges, they are strongly disposed to blame the surgeon for not having applied the appropriate dressing, ignoring the fact that they are not giving the opportunity for natural recovery. If, therefore, any part of the hand or arm has been wounded, it should be carried in a sling. If the wound is near a joint, a splint will probably be applied to prevent motion of the joint. In every wound of the fingers, of any extent, this is a necessity. If the wound is on the foot or leg it is proper for the patient to rest in bed or on a couch for one or two days at anyrate.

Then the wound needs protection from irritation of its surface, from atmospheric influences, and for this purpose a dressing is applied. It is commonly supposed that some application should be placed on the wound to promote its healing, or something to "draw" out of it any inflammation that may arise. Hence the use by the public of all sorts of healing ointments, white zinc ointments, basilicon ointment, and so forth. It may be taken as a general rule that this is entirely erroneous. Such applications are entirely discarded by modern surgeons. If the person be in a good state of general health, the natural reparative powers of the body are perfectly sufficient for all healing purposes. The all-important point is to give nature a full opportunity for doing her own work by keeping the wound clean. The applications used now are almost entirely such as are designed to accomplish this purpose by preventing decomposition occurring at the site of the wound, which decomposition is set up by dirt in the wound or by particles deposited from the air, as explained in Section XIII. p. 384. Such applications are considered at length in Part III. Section IX. p. 910, and are called antiseptics. Antiseptic solutions are employed to wash the wound, and the commonest in use are the carbolic acid lotion, 1 part in 40 of water (p. 910), or the lotion of sulpho-carbolate of zinc (p. 911), or the lotion of boracic acid (p. 911), or permanganate of potash solution (p. 912), or a weak perchloride of mercury solution (1 in 5000, p. 912), or the iodine solution mentioned above. If the dressing is soaked in any material it should be one of these. But a perfectly dry dressing is the simplest, and is often to be preferred, and ought nearly always to be so in the case of clean-cut wounds. At the same time the dressing should be of such a nature, and should be so applied, that it will not cause any discharge to be retained, but will permit it to escape or will absorb it—lick it up. For such a purpose nothing is better than the absorbent wool or gauze now obtainable from every druggist. Such gauze is now obtainable impregnated with corrosive sublimate, or boracic acid, or eucalyptus, or other antiseptic. For domestic and popular use nothing could be better than this; a layer—dry—would simply be applied over the wound and would be secured by a roller or triangular bandage. An excellent oily application is made with 3 parts of olive-oil and 1 part of terebene. A piece of lint is soaked in this and placed over the wound and is then covered with a dry piece of lint or a layer of absorbent cotton, the whole being secured by a bandage. Simple water dressings are seldom desirable, since they promote decomposition, and the wound thus becomes foul-smelling.

It remains to be added that surgeons now always provide for the escape of discharge from a wound, and take care not to apply dressing in a way to prevent the escape of any matter that may form. In the case of deep wounds a piece of fine india-rubber tubing is passed into the wound, so that its one end is at the very bottom of the wound and the other end projecting. This provides an escape for any matter or fluid that would otherwise accumulate. As the wound heals from below, the tube is made shorter and shorter, till it may finally be removed altogether.

The Redressing of Wounds.—After a wound has once been properly cleansed and dressed it is well to leave it undisturbed for several days, undoing the dressing every day being only a cause of irritation, except in special cases. If the wound has been clean cut and is likely to heal readily, it should not be disturbed for four or even six days. If the parts, however, have been bruised or torn, earlier redressing will be necessary for the removal of matter and any separated parts of the tissue. Probably every second day will be sufficient, though more frequent redressing is necessary when there is much discharge. Each case, however, must be judged by itself,

the rule being that so long as the part is comfortable, and pain, or heat, or throbbing is not arising, it may be left alone. When the wound has been stitched, a few of the stitches are removed on the third day, others perhaps a day later, and so on. In undoing the dressing, no roughness should be allowed. If the dressing adheres, it is to be softened by a stream of water, carbolized or iodine water, and the lint or cotton soaked till it slips off of itself. A fresh dressing should be already prepared, and after the wound has been well bathed with the antiseptic solution, reapplied.

Subject to the above explanations regarding the general treatment of wounds, we may now give brief directions for the treatment of each of the varieties of wounds mentioned.

The Treatment of Incised or Clean-cut Wounds.—Having stopped the bleeding by raising the part, by using cold water, by firm pressure for a minute or two with a small piece of dry lint, or lint soaked in cold water, or in water tinged to a light sherry colour with tincture of iodine, or by some of the other methods noted in detail on subsequent pages for cases of serious bleeding, the person must proceed thoroughly to clean out the wound, removing all clots of blood, all dirt, fragments of hair, or other foreign matter. This is to be done by a gentle stream of cold water, or carbolic acid lotion, or the iodine water already spoken of. The cut surfaces must then be brought carefully and accurately together and held so by strips of adhesive plaster, stitches being preferable if anyone competent to insert them be present. A dry piece of lint or absorbent cotton, or lint soaked in the oil and terebene mixture (p. 971), is laid over it, then another larger piece placed above it, and the whole secured with a roller or triangular bandage. If the wound be on the arm or hand, the limb is secured by a broad sling (p. 962). In the case of a finger or a wound near a joint a splint should be applied. A piece of thick cardboard, cut of a suitable size, covered with a layer of absorbent cotton, will suit, and it is secured by the bandage. The patient should rest if the wound is at all severe. Redressing is not to done for four or six days, and subsequently every second or third day if needful. In the event of much pain, swelling, &c., arising, it may be advisable to remove the dressings, and if the wound seems much inflamed, cold or iced water cloths should be applied for ten minutes or so at a time at intervals of an hour or two till the pain and swelling are relieved. If the bulging of the wound seems to indicate any fluid retained within it, a strip of plaster should be removed to permit of its escape. The gentle insertion of a fine probe at one corner of the wound will permit of the escape of such fluid; a blunt-pointed knitting-needle, previously cleaned by being dipped in boiling water, would suit. The dressings would then be reapplied *lightly*.

The Treatment of Punctured Wounds.—These wounds are to be treated as detailed above for clean-cut wounds, with one notable exception—*the lips of the wound must not be closed, but kept open.* It is so difficult to ensure the thorough cleansing of such a wound that provision must be made for the escape of fluid or matter from the bottom of the wound. The lips of the wound are, therefore, to be kept *slightly* apart by the insertion of a very small piece of absorbent cotton or lint. If in two or three days there is no sign of any fluid, the wound is then allowed to close.

The Treatment of Bruised and Lacerated Wounds.—In these cases bleeding being arrested, and in such cases bleeding is comparatively slight, the wound must be very effectively cleansed. If this is necessary in clean-cut wounds, it is more necessary here, where death of tissue and decomposition are almost certain to occur. No attempt is to be made, however, to close the wound by strapping or similar method. If pieces of the tissue have been torn or pressed out of position, without being wholly separated from the body, they are to be gently replaced, care being taken that they and the parts to which they are restored are perfectly free from foreign particles. The cleaning should, in such cases, be done with the iodine water or other antiseptic. A layer of lint or absorbent cotton, soaked in the antiseptic, is then placed over the wound, and covered with a piece of oiled silk to prevent the dressing becoming dry. If the terebene and oil dressing is used, it should be covered with a layer of absorbent cotton, no oiled silk being necessary. A lightly-applied bandage then secures the whole. The part must be kept absolutely at rest. Probably in two days redressing will be necessary, and if there is much destruction of parts, more frequently.

The Treatment of Wounds of the Head.—Very special care requires to be bestowed on all injuries to the scalp, the risks of inflammation, suppuration, and erysipelas are so great. Here, if anywhere, there is no safety except in the strictest possible cleanliness. Even the

coolest person is apt to lose his equanimity at the sight of a mass of hair matted together by clotted blood, from under the edge of which a red stream trickles, and is likely to think that the best thing to do is to cover the whole thing up out of sight, and leave it to providence. This is just the course that must never be adopted. The masses of hair must be quickly parted, till the whole extent of the wound is clearly shown. If the bleeding be little, the person should proceed at once, by means of cold water and pieces of *clean* lint or cotton, to remove all particles of congealed blood, not over the wound only but from every part of the scalp. This must be done thoroughly once for all, and the person must not desist till the hair is completely cleaned, disentangled, and then dried. Then for an inch or so all round the wound the hair should be removed quite close to the scalp by a pair of sharp *clean* scissors. The wound itself must be carefully cleaned by a stream of cold or preferably iodine water. If blood is still oozing from it, a pad of lint wrung out of the water is to be firmly pressed upon it for a minute or two. If the blood be welling out of the wound, the time necessary to complete the cleansing process is too long, and the bleeding must be arrested at once. It will be well therefore to clear a space at once round the wound with the scissors to enable one to get at it thoroughly. But this is not to be done by slashing, haphazard snips, needlessly cutting away large masses of hair. When the wound has been effectually got at, a pad of lint wrung out of cold water or iodine water is pressed firmly into the wound, and if an assistant be at hand he will hold it so, while the person taking charge proceeds to disentangle the hair and clear away clots and foreign material. When all this has been done the wound is to be closed and dressing applied. All clean-cut wounds should be closed as accurately as possible. It is not easy to do this with plaster, because of the difficulty of it securing a hold on the hairy scalp. A surgeon might or might not use sutures, but certainly no unskilled person ought to. The person will do what he can by means of plaster strips, and perhaps by aid of the pressure of small pads of lint on each side of the wound, to bring its lips together. He should apply a dressing of lint soaked in some of the antiseptics named, but preferably terebene and oil or carbolic acid oil, covering lint soaked in any watery solution with oiled silk, but the oily preparation with a dry layer of lint or absorbent cotton, and then fix all with a suitable bandage (see p. 960). If the wound be bruised or torn, no attempt will be made to close it, the antiseptic dressings will be applied, and redressing practised as often as necessary to keep the wound perfectly clean and free from smell. At one time it was not uncommon to pour on the wound friars' balsam, or other sticky substance, to seal it up and help to arrest bleeding. This is only too apt to cause the retention of discharge and dirty material, and is not at all advisable.

The treatment of wounds has been entered into in some detail. This has been done, it is needful to say, not to enable anyone to do without the aid of a surgeon in more than the class of very slight wounds which most people regard as too trivial to require such aid. For anyone who is within reach of such skilled help, and yet attempts to treat a wound of any severity, commits what is really a grave error. It is much wiser, and in the end much more economical, to get immediately competent assistance, when it is at hand, than to be compelled, after some time and when the wound has failed to heal, to resort to a surgeon, when the simple healthy wound has been converted by some excusable error or some circumstance that an unskilled person could hardly be expected to notice, into an unhealthy sore, inflamed by irritation and ulcerous by decomposition. But the author is compelled to have regard to the fact that this book will be in the hands of very many who are remote from medical aid, to whom from geographical or other circumstances any skilled help is simply unobtainable, and who must either attempt to treat such injuries as they best can or let them alone to "go to the bad" or to get well, as circumstances or fortune may determine. It is ridiculous to say that it is useless to attempt to lessen the hardships which such persons are constantly called upon to endure. If it is almost universally admitted, as it now is, to be proper to teach the principles of first aid to the injured to those who live in the midst of large communities, where surgeons are to be found on every hand, it ought to be even more readily admitted to be desirable to place even more extended information within the reach of those isolated from all such resources. Therefore the author has considered his work would not be properly done, unless he stated as clearly and simply as he could the broad general principles which all surgeons accepted as the basis of their practice, and leave these to be applied to each

particular case as the common sense of the individual, guided by them, should determine.

The Treatment of Bruises.—The term bruise or contusion (Latin *contundo—con,* and *tundo,* I beat) is restricted to such injuries as are produced by severe pressure, or by a blow from a blunt instrument, or by a fall on a hard substance, when the skin is not broken, or only very slightly broken, as when an **abrasion** has been caused, that is, when the scarf-skin has been removed and the sensitive bleeding true skin uncovered. Bruises may be of all degrees of severity, from that caused by a pinch where only the skin is squeezed sharply, to that which extends into the layers of fat beneath the skin, causing rupture of many small vessels and injury to other deep parts, and to that degree in which the whole tissues of the part may be reduced almost to pulp. Large vessels may be ruptured and extensive bleeding occur, leading even to the producing of pulsating blood tumours, forming a **false** or **diffuse aneurism** (see p. 244). The important point between a bruise only and a bruised wound is that the former is covered by skin which protects the injured tissues from external influences, and especially from the attack of atmospheric agencies, leading to decomposition and suppuration, while the latter is open to all such unfavourable influences. Of so much significance is the protection afforded by the unwounded skin that very serious and extensive bruising of parts may occur, may produce much swelling, inflammation, and pain, and yet recovery occur without the slightest formation of matter or apparent loss of tissue. It will be evident, then, that any method of treating a bruise which breaks through the protective covering of the skin will be highly improper. Nothing could well be more injudicious than the use of leeches or the lancet to reduce the swelling by removal of the effused blood, since thereby a way would be opened for the entrance into the injured tissues of the agents of putrefaction. Yet leeches used to be, and in some classes of society are yet, the resort for such a bruise as that which produces a black eye. Besides the error already noted which such treatment commits, there is another. A leech does not remove blood already poured out from the vessels and diffused among the soft parts, but it opens other blood-vessels and removes fresh blood. The purpose of their application is not served, and the wound they cause adds an altogether unnecessary element of risk.

The first signs of a bruise are redness, swelling, and discoloration. They are all due to the injury done to the soft parts, and specially to the blood-vessels. The swelling and discoloration which follow are caused by the blood poured out of the damaged blood-vessels, and to the outflow of serum from the blood and other elements of blood for the repair of the damage. The discoloration is produced entirely by the effused blood. It may occur within an hour or two of the injury, if it is the surface blood-vessels that are injured, or not for a day or two if deeper parts are injured, while the skin has escaped. Thus it may not appear for twenty-four hours, if the tissue lying immediately beneath the skin is damaged, and will not appear on the surface for some days if the injury has damaged deeper parts, muscles and the tissues between them. In the latter case the discoloration very frequently appears at a considerable distance from the seat of injury, because the escaped blood has gravitated downwards from the injured part.

The technical term applied to this poured-out blood is **ecchymosis,** or **extravasated blood.** Ecchymosis is derived from the Greek *ekchymōsis,* from *ek,* out, and *cheo,* I pour, and the word extravasated is Latin, from *extra,* outside of, and *vasa,* the vessels.

The discoloration resulting from a bruise is at first dark-purplish, and its margin is well marked. In two or three days the margin is spread and less defined, and the colour is more violet in tinge. About the fifth day it is green, in a day or two more yellow, and in one or two more days it has disappeared. The margins show these changes sooner than the centre, so that while the chief part of the discoloration is still dark in colour, bluish or green, the margins are greenish-yellow or yellow, and an irregular mottled appearance results when the blood has been irregularly distributed in the tissues. These changes of colour are due to changes going on in the effused blood, part of the blood being quickly absorbed by the lymphatic vessels (see p. 200) and passed back into the circulation, and undergoing also a bleaching process, as it were, while it lies among the tissues. As the blood and other fluid are absorbed the swelling gradually diminishes, and by the time the colour has become yellow it has almost disappeared. The repair of the parts damaged by a bruise is practically identical with the process of repair already described as going on when a wound heals by first intention. Of course the result of a bruise may be such destruction of

tissue that a collection of matter results, which would require removal by an incision; and again in persons of depressed health a bruise might end in an abscess, sloughing of the skin, and so on, which in a vigorous healthy person would have healed without trouble.

A considerable amount of pain, and some degree of inflammation and throbbing, attend a bruise. The degree of pain will largely depend on the amount of swelling, implying more or less pressure on nerves and other sensitive structures, but the inflammation usually soon subsides.

The Treatment of Bruises.—Reasoning from what has been said there are two plain indications of what should be the aims of treatment. First, the swelling and discoloration being the result of the breach of blood-vessels in or beneath the skin and the escape of blood, the immediate thing to do is to stop the bleeding; and if that can be done speedily the swelling and discoloration will be all the less. Second, after all bleeding has ceased, the swelling and discoloration gradually disappear by the removal of the poured-out material by the agency of the lymphatic and other vessels. Any means that will stimulate the vessels to this work will shorten the process.

First, then, what will arrest the bleeding? Cold applications.

Second, then, what will stimulate absorption? Hot applications.

Immediately a blow or fall has been sustained, likely to lead to swelling, &c., resort should be had to cold water. The part should be diligently bathed, the sponge or cloth soaked in cold water being laid on, only for an instant, and then renewed, to maintain the cold. The part affected should meanwhile be held high, not allowed to hang. No delay should be allowed to occur till one learns whether swelling is going to take place or not. In very many cases the swelling may be almost prevented if the cold water be instantly applied, and the more surely will this be the case the more the injury is on the surface, where the cold can act quickly, the less surely the more deep-seated it is. Such applications also greatly relieve the pain and diminish the chance of subsequent inflammation.

In households where cold water is always at hand, a very great amount of needless pain and disfigurement would be saved children if mothers and nurses would instantly rush to the cold water, and not waste time condoling and sympathizing with and kissing the unfortunate child. The cold should not be continuously applied for a long time. A few minutes are all that is necessary, and then after a few minutes' interval another two or three minutes' application. All other popular applications, a coin, a piece of raw beef, derive any value they possess—which is slight at the best—from their being cold. Some astringent lotions are useful, when applied immediately, in diminishing the escape of blood. The arnica lotion is one specially in popular favour, but it should not be employed if the skin is at all broken; and another which seems to be much more useful is the extract of witch-hazel, or hazeline, and which is sold in America as Pond's extract.

After measures have been taken to arrest the bleeding, the bruised part should be kept at absolute rest for a time, and nothing further done for some hours at anyrate to remove any swelling that may have occurred. Specially if the bruised part be in the neighbourhood of a joint must absolute rest be insisted on, not for an hour or two, but till all swelling, pain, and tenderness have passed away. The attempt to use the part earlier than that will certainly be followed by an increase of the swelling.

After the lapse of some hours one may endeavour to hasten the diminution of the swelling. For this warm applications are best, gentle bathing of the part with warm water being the simplest; and if this be repeated at short intervals a speedy restoration to the natural appearance may be expected. Any increase of swelling or pain would be an indication for stopping it and resorting rather to cold. Rubbing the part with one kind of stimulating lotion or another is frequent, but of somewhat doubtful value. Probably of much greater value would be gently but firmly stroking and manipulating the part in the manner described under Massage (p. 772), but such stroking and manipulation ought never to be so performed as to excite pain or renew inflammation.

The employment of such measures, the immediate use of cold, and the use later of warm bathing, is the appropriate means of dealing with a **black eye**; and the same methods should be employed for a strain or sprain of ankle, wrist, &c., combined with perfect rest in a raised position.

A caution is necessary. Where a bruise is very extensive and severe, cold must be applied with great caution and judgment lest the tissues, already much damaged, have their vitality still further lowered. Many very extensive bruises

undergo repair with wonderful completeness, if the skin be not wounded anywhere. Probably in extensive bruises the only assistance an unskilled person could render would be to have the person placed comfortably in bed, the bruised part being most carefully handled and supported equally on all sides. If the person has to be carried for some distance, the care with which this is done very often determines the issue, favourable or otherwise.

THE ARREST OF BLEEDING.

The Distinction between Bleeding from an Artery, a Vein, and Capillary Vessels.— The distinction here indicated is one between the kinds of vessels from which the blood is escaping; and if reference is made to pp. 225, 226, the differences will be made plain. The capillaries are exceedingly fine vessels, too minute to be made out without the aid of a microscope. The arteries are of a great variety of size in cross section, but are thick-walled resisting tubes, the smaller ones markedly contractile, the larger ones specially elastic. The larger ones remain open when they are cut across. The veins on the other hand are thin-walled, collapsing when empty, but as readily widening out to a large size when filled with blood. The arteries, consequently, will resist closing by pressure to a considerable extent, while the veins will be easily closed thereby, and the capillaries are quite readily compressed. The flow of blood will be quite easily stopped by comparatively little pressure in veins and capillaries, while that in arteries will persist despite a considerable amount, specially when they are deep-seated and protected by surrounding muscles and other soft parts. From capillaries, and also the more minute arteries and veins, the blood will ooze out, though when the wound occupies a large area much may be lost in a comparatively brief period. A wounded artery may be distinguished from a wounded vein, when both are of a larger size, by the manner in which the blood flows, and its appearance. From a wounded artery the blood will issue in jerks or spurts, corresponding to the strokes of the heart, while from the vein it will pour in a steady stream. The blood from an artery is of a brighter, more scarlet hue than from a vein, from which it is darker or more purplish in colour. Another point it is of importance to notice. From both sides of a wounded vein the blood escapes, but more particularly from the end nearer the extremity of the body, the end farther from the heart, while from a wounded artery the blood escapes only from the side nearer the heart. For the blood in an artery is flowing from the centre of the body to the extremities, while it is being returned in the vein from the extremities to the heart. It is often of importance to observe these distinctions, because, in the event of pressure by a pad or a bandage being necessary to stop the flow, it is clear that in the case of an artery it should be applied on the side of the wound nearer the heart, while in the case of a wounded vein the opposite course will arrest the chief bleeding, or hæmorrhage, as it is called, from the Greek *haima*, blood, and *rhēgnymi*, to burst.

Bleeding is arrested naturally by the sealing up of the wounded vessels by the clotting of the blood at the mouths of the vessels, round about and over them, and within them up to the level of their first branches. Besides, there is poured out of the wound a coagulable material or lymph, further sealing them, and subsequent changes take place, similar to those for the repair of a wound, by which they are effectually closed. As part of the process of repair, the vessels are permanently closed by the formation of connective tissue, such as takes place in a wound, so that after a time nothing is left of the part of the vessel where the wound occurred but a fibrous cord, this change taking place in the whole length of the vessel up to its first branch beyond the seat of injury. Before such changes have had time to occur a renewal of the bleeding may take place by extra pressure in the vessels, causing the sealing to give way and displacing the clots, or by rough handling; and in the case of large vessels it may occur several days after the injury. In such cases it is called **secondary hæmorrhage.** An important element in the natural closing of a vessel is the elasticity of its walls, which, when it has been completely divided, leads it to retract within the wound, when its mouth is closed by the pressure of surrounding tissues. There is, consequently, less bleeding as a rule from an artery completely divided than from one only wounded, since in the latter case the artery is unable to retract.

The Methods of Stopping Bleeding.— The various means of arresting hæmorrhage are as follows:

Raising the Part;
The Application of Cold;
The Application of Pressure;
The Use of Astringent Substances or Styptics.

How does raising the part help to stop bleeding? Suppose blood is flowing from a wound in the wrist. It is plain that if the arm be allowed to hang, a plentiful supply of blood will readily pass down the limb to the wounded part, while the blood returning from the hand will return up the arm less readily, and there will be a determination of blood to the wound; while if the arm be held high up less blood will pass up to the wound, and the blood returning to the heart will do so more readily, with the result of a great diminution in the escape from the wound. Similarly if the foot or lower limb be wounded, the person should lie down or recline, and have the leg raised above the level of the head. Another thing to be attended to is the removal of any hindrance to the ready return of blood to the heart from the injured part. If, for example, a wound has been inflicted on the lower part of the leg, or if a varicose vein has burst, the pressure of a tight garter or similar contrivance will delay the return of blood up the limb and make the bleeding very free. Similarly in the case of bleeding from the hand or arm, clothing tight at the arm-pit, through which the vessels pass, will greatly aggravate the bleeding. When the part is raised, then, all tight clothing should be loosened. Take as another illustration of the same thing, bleeding from the nose. The tendency is for the person to hang the head to prevent the blood flowing on to the clothing, whereas the head should be held high. If the person wears a tight collar, the hanging of the head causes the veins of the neck to be pressed upon, the blood is prevented freely returning from the head, and the bleeding is all the more free. In addition to holding the head up, therefore, see that everything round the neck is loosened. Cold diminishes bleeding by causing the vessels and tissues to contract, and astringent substances like borax, alum, tincture of steel, tannin, friars' balsam, matico, act in the same way. Astringents also coagulate fluid parts of the blood and promote the formation of a scab. Collodion, when it sets, causes contraction of the parts, and also aids in sealing the wounded vessels.

But none of these means of stopping bleeding is equal to that of properly applied pressure, by which the bleeding vessels are forcibly closed. It is applicable to every sort of bleeding, at least from the surface of the body. Pressure may be applied directly on the wound itself in every case, altogether irrespective of the nature and size of the wounded vessels. In many cases the pressure of the thumb laid directly over the wound will be sufficient, and if the pressure be maintained for a little time that may be sufficient to cause the bleeding to cease entirely. If a small pad of lint, or a piece of cloth made into a pad, a strip of handkerchief rolled up, for example, be laid just on the wound and be pressed into it by the thumb, or held firmly on it by a bandage, the arrest of bleeding will be still more satisfactory. But when the bleeding is profuse, the mistake commonly made is to cover over the wound with large pieces of cloth, handkerchiefs, bandages, &c. The result often is that the pressure is spread over a large area, is not properly adjusted over the wounded vessels, and under the mass of coverings the bleeding may go on uninterruptedly. The pad, then, should never be very large. It need never be any larger than is just sufficient to cover the wound, and then it is easy to concentrate the pressure upon the bleeding surface. But while pressure thus applied will be sufficient to arrest the bleeding for a time, it is often insufficient for its permanent stoppage. If a large artery has been wounded the pressure might be kept up for a time, but as soon as it is removed it would start afresh, because the large vessel has not had time to close, and gapes again as soon as the pad is removed. In such a case if pressure were to be maintained long enough to permit complete sealing to occur, the time would probably be so long and the pressure so considerable that the vitality of the tissues would be seriously impaired. Such a method, therefore, while highly satisfactory for a limited time, must give way to others for the permanent closure of the wounded vessel. These methods will be noted in the paragraphs on arterial bleeding. We shall now note the steps to be taken to arrest bleeding under various circumstances.

To Arrest Capillary Bleeding, elevate the part, apply cold water, or the iodine water, mentioned on p. 965. If that is not sufficient fold a piece of lint into a small pad, just enough to cover the wound, and exert firm pressure upon it for a little. The pad may be secured by a bandage. When it is to be removed, it must be thoroughly saturated with water, so that it is washed and not torn off.

To Arrest Bleeding from a Vein.—Follow the above rules, but whenever the bleeding is of any amount apply pressure without delay.

To Arrest Arterial Bleeding.—When the smaller sized arteries are wounded the appli-

cation of cold and simple pressure is usually enough to stop all bleeding, not only for the time but also permanently. But the larger arteries, if divided, allow blood to escape so rapidly that the bleeding will be sufficient to cause death in a minute or so if uncontrolled. In the case of the smaller vessels there is time to expose the wound, to clean it, to ascertain exactly where the wounded vessel is, and to apply appropriate pressure directly over the spot. But in the case of the larger arteries one must arrest the bleeding immediately in some way or another, and take time subsequently to examine the wound. Then again the place where the artery is wounded may be so deep that it is difficult to get pressure properly applied to it, and although one has applied pressure on the surface the blood may be forcing its way among the tissues. It is clear that the bleeding at the wound would be arrested if the main trunk of the vessel were closed. Thus, suppose bleeding occurring at the palm of the hand which resists all the simple means of stopping it, it is evident that if one could block the main vessel at some part of its course through the arm, the supply of blood to the hand would be arrested and the bleeding would cease. Of course if this blocking were to be maintained for a long period death of the parts deprived of their blood-supply would arise. It must never be forgotten, therefore, that this arrest of the circulation is only resorted to in the emergency, till skilled assistance can be obtained to apply appropriate treatment. Now severe accidents wounding large vessels of one limb or another are not uncommon in large public works, in the harvest field, &c., and there is no manner of doubt that many lives would be saved annually if this method of temporarily arresting hæmorrhage were well known. Even apparently simple accidents frequently end in death from ignorance of such procedure. For example, in the city of Glasgow, a year ago, a beadle of one of the churches, in cleaning a window, accidentally broke a large pane. The glass tore a deep ragged wound across one wrist, opening one of the chief vessels of the forearm. These vessels are so near the surface, and so easily commanded, that, had the man known how, he could easily have stopped the bleeding by his uninjured hand. But he was completely ignorant, and ran to the nearest doctor's house. The doctor was not at home; and he ran to another, and so from one door to another till, from loss of blood, he fell exhausted and speedily died. The smallest amount of knowledge on his own part, or on that of the occupants of the various houses he called at, would have saved his life. We shall, therefore, point out the direction of the chief vessels of the limbs, noting the places where the main trunk comes near enough the surface to be readily commanded, and then show how, by the simplest possible contrivances, bleeding, even from the largest vessels, can be arrested for a time till medical aid can be obtained.

To Arrest Arterial Bleeding from the Arm.—The course of the main artery of the arm is shown in Fig. 367, reproduced from p. 227, where it is more fully described. The artery enters the arm through the arm-pit, midway between the front and back folds, and its course is indicated by a line drawn from the middle of the arm-pit over the arm to the centre of the elbow in front. If one places the thumb on the inner side of the upper arm, midway between the arm-pit and the elbow, and on the line that has been indicated, and if one presses from within outwards, one will press the artery against the bone; its beating will be readily felt, and by increasing the pressure the vessel can be closed. This would stop entirely any bleeding occurring in the forearm and hand, so long as the pressure was maintained. The artery is easily reached, because it is not buried among muscles at any part of its course. In Plate XVI. fig. 11, the fingers are seen pressing in the direction indicated for the purpose of controlling bleeding. The same figure shows another situation in which pressure may be exerted to arrest the supply of blood to the arm. The main trunk of the arm is a continuation of what is known as the subclavian artery (p. 226), and on its way through the chest to the arm it passes behind the collar-bone. In this situation, by pressing the fingers behind the centre of the collar-bone, its pulsations are easily felt, and if

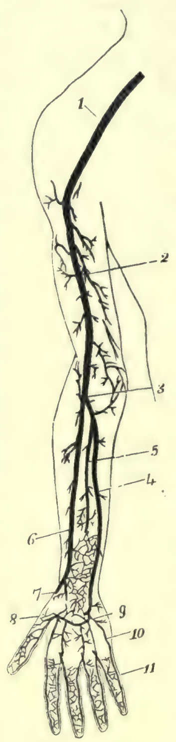


Fig. 367.—Arteries of the Front of the Arm.

1, the axillary artery; 2, the brachial artery, dividing at 3 into 6 the radial, and 4 the ulnar artery, the ulnar giving off a deep branch 5. 7 the radial artery, winding round the back of the wrist to reappear at 8. Between 8 and 9 the superficial arch in the palm giving off branches, as 10, to end along the side of the finger, 11.

very firm pressure be exerted backwards, as well as downwards, the vessel may be compressed against the first rib. Pressure need not be exerted here unless when the wound of the arm is very high up. The handle of a large key, first padded with a piece of cloth, may be used instead of the fingers.

Now while pressure with the fingers is the safest and best method of stopping the flow of blood in an artery, they readily become fatigued; and if any time elapses before aid can be obtained, it becomes necessary to employ some other means. A pad may be placed over the vessel and firmly pressed upon it by means of a bandage. The pad and bandage may be made by the simplest things. A stone wrapped up in a handkerchief to prevent its hard surface injuring the skin may be employed, and secured by another handkerchief applied like a triangular bandage (see p. 962), or a long neckerchief may have a large knot tied upon it, and may then be fixed round the arm, so that the knot presses on the artery (see fig. 6, Plate XVI.), which also shows how the requisite degree of pressure may be employed by slipping a piece of wood, a knife, &c., under the neckerchief after it has been tied, and twisting it up.

To Arrest Arterial Bleeding from the Hand it may not be necessary to compress the main artery of the arm. Make a firm pad with a pocket handkerchief, in which a small smooth stone is wrapped: let this be placed in the palm, and let the patient close the hand tightly over it; then secure the hand in this position by means of a bandage. It may also be stopped by the pressure of a pad across the front of the wrist to close both vessels.

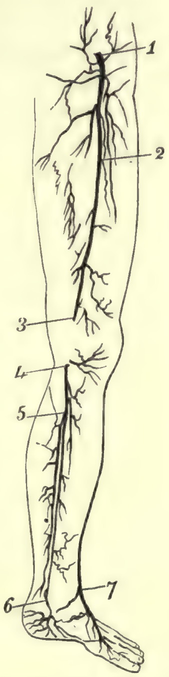


Fig. 368.—The Arteries of the Lower Limb.

1, the femoral artery, passing deeply into the thigh at 2 and winding into the ham at 3; 4, its posterior tibial branch, which passes to the ankle at 6, giving off a large branch at 5; 7, part of the anterior tibial artery shown in Fig. 125.

To Arrest Arterial Bleeding from the Leg.—The course of the main artery of the leg is shown in Fig. 368, reproduced from p. 228. If the leg be turned somewhat outwards and the knee be half bent, a line drawn from the middle of the groin over the thigh to a little above the inner side of the knee-joint indicates its course. Such a line is shown in figs. 1 and 2 of Plate XVI. In the upper third of the thigh, the vessel is not covered by muscles, but lies under the skin and fat. Pressure exerted here will close the vessel and so arrest bleeding lower down. Fig. 10 of Plate XVI. shows how the thumb of each hand may be placed alongside of each other to accomplish this. Here certainly it would be difficult to maintain efficient pressure for any length of time, and the use of a pad of some kind is necessary. Fig. 2 shows the application of a knotted cravat, twisted up by means of a knife to accomplish the end desired.

When, however, the bleeding occurs in the foot or lower leg it is not always necessary to block the vessel so high up. From the inner side of the knee the vessel passes back into the space behind the knee-joint, the ham, and pressure may be exerted quite effectually here by placing a roll of bandage, a stone wrapped up in cloth, &c., in this space, and tightening it up as shown in fig. 9, Plate XVI.

To Arrest Bleeding from the Head and Neck, keeping the head high, employ cold water, and apply firm pressure directly over the wound. Fig. 369, reproduced from p. 227, shows the position of the main arteries. When the head is thrown back and to the side the line of one of the chief muscles of the head and neck is shown in relief, and this muscle covers the main

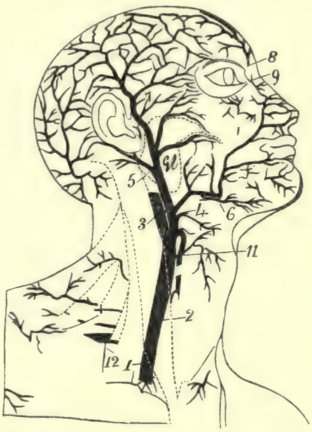


Fig. 369.—Arteries of the Head and Neck.

1 and 2, the common carotid artery, 2 being the part covered by muscle as indicated by dotted lines; 3, the internal, and 4, the external carotid. Some branches of the external carotid are shown, 5 to parts behind the ear, 6 to parts under the chin, 7 to the side of the head, and 9 to the nose. 8 points to a branch of the internal carotid which comes out from within the skull above the eye and is distributed over the forehead. 11 is a branch passing down to the front of the neck. 12 points to part of the subclavian artery. *Gl* shows the position of the salivary gland.

artery and protects it from injury up to the level of the angle of the jaw, and beyond which the artery lies less deeply, where it divides. Firm pressure here will be necessary if the arteries beyond be wounded. In cases of cut throat branches from these vessels are often wounded, but bleeding may be arrested by direct pressure on the wound, and by pressing the edges of the wound together between fingers and thumb.

To Arrest Bleeding from the Nose, let the person sit erect, holding the head high; let a large sponge soaked in cold water be held over the nose. If this is not sufficient, as it commonly is, let the nostrils be held firmly for a little, or let cold water, or cold water with borax or alum dissolved in it, or the iodine water mentioned on p. 969, be gently injected by means of a syringe up the nostril. If this is still insufficient the nostril should be plugged by means of a piece of lint, rolled up in the shape of a cone and pressed up, small end first, into the nostril, the large end projecting outwards. Sometimes it is necessary to plug not only the external openings of the nostril, but also the internal opening, that leading into the back of the throat. This, however, can be done only by a surgeon.

Tourniquets (from the French *tourner*, to turn) are appliances used to check bleeding. The pad and bandage, tightened by the twisting of a piece of stick, is a rough and ready made tourniquet; and in Plate XVI. figs. 3, 4, and 7 show various forms. The ordinary form of tourniquet consists essentially of a pad to be placed over the artery to be compressed, of a strap to fix it, and a screw to tighten it. Fig. 4 in the plate shows Petit's tourniquet. The figure shows it provided with a pad, but besides the screw it may consist only of a strap of stout webbing and a buckle. A roller bandage is then used as pad. It is unwound a little; the roller being placed over the artery the end is passed once or twice round the limb to fix the bandage. Then the strap is put round over it, so that the screw is on the opposite side of the limb and the buckle between the screw and pad. The strap being pulled through the buckle and fixed, it is then rapidly tightened by turning the screw. This must be done rapidly, else the veins would be compressed a little before the artery, being nearer the surface than the artery; the blood being prevented returning from the limb before it was stopped passing down into it, the limb would be overcharged with blood. Fig. 3 of the plate shows a tourniquet made of a piece of wood, through slits in which the strap is passed, the strap having a pad fixed to it. After the strap is tied it is rapidly tightened by twisting it up with a piece of wood. Fig. 7 of the plate shows a tourniquet made of a long india-rubber band, as thick as one's little finger. It passes through a block of hard wood, and a channel is cut in the block of such a size that the india-rubber can pass into it only when it is well stretched, and it prevents the band from slipping as soon as the stretching force is removed. In fig. 8 it is shown applied. The rubber band is passed once fully round the limb, and then both ends are brought round, and are so strongly stretched that they are able to pass into the groove where they are gripped.

Bleeding from a wounded artery is permanently arrested by the artery being tied either at its wounded end or in its course at a little distance from the wound. Fig. 5 of Plate XVI. shows a pair of artery or catch forceps. By means of these the end of a cut artery is picked up. The forceps being then shut, the spring keeps them so, and the mouth of the vessel is kept closed till a ligature is put round it and tied, after which they are released.

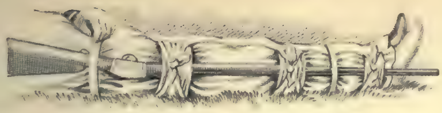
It must be observed that it is never necessary to apply a tourniquet to stop bleeding from a vein. Direct pressure over the wound by a pad held firmly by the fingers, or a pad secured by a bandage, will always be found effectual.

POISONED WOUNDS, INSECT STINGS, SNAKE BITES, AND OTHER KINDS OF POISONED WOUNDS.

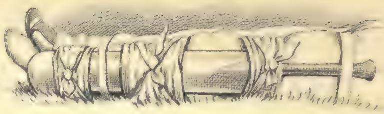
Poisoned Wounds are dangerous out of all proportion to the size or situation of the wound, and out of all proportion also to the amount of poisonous material which has gained entrance to the body. For the poison is almost invariably of animal origin, capable of multiplying in the tissues and blood, and, just as "a little leaven leaveneth the whole lump," is capable of profoundly affecting the whole body. The description given in Section XIII. (p. 384) of the action of minute organisms is applicable to the way in which poison introduced by a wound affects the body. The material introduced sets up changes in the part of the nature of fermentation, and may be limited to the immediate surroundings of the wound, leading only to the formation of abscesses or ulcers, but may extend along the blood and lymph channels, reaching glands and setting up inflammatory action in them, and perhaps leading to changes

TEMPORARY TREATMENT OF FRACTURES.

Plate XV



Rifle applied as splint to a broken thigh-bone.



Cricket-bat applied as splint to broken lower part of leg.

Temporary treatment of broken collar-bone

Splints applied to broken upper arm

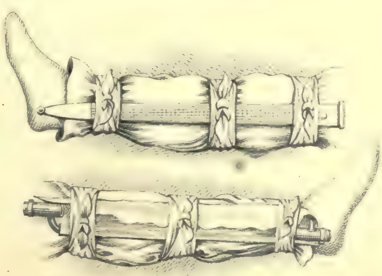
Splints applied to broken fore arm.

Triangular bandage adapted as sling for arm.

Bandages for shoulder hand, elbow, and a small arm sling

Triangular bandage arranged as 'shawl' cap for the head

Temporary Splints of huntsmans whips for broken upper arm.



Broken fore leg with scabbard and bayonet as splints

Handkerchiefs applied as bandages for fractured lower jaw.

in the blood, showing themselves in fever, diarrhœa and all the symptoms of blood poisoning (p. 236). Now the poisonous material may be on the instrument with which the wound was inflicted. For example, wounds received by medical students in the dissecting-room, by a surgeon performing a post-mortem examination, by a veterinary surgeon or others during the process of cutting up or removing the hide from an animal which has died of some disease, are all of a very serious nature, since the knife with which the wound was inflicted is smeared with the juices from the dead body, which are thus directly introduced to the tissues of the person. Insect stings, bites of venomous reptiles, &c., belong to the same class, but will be discussed separately.

The wound, however, may have originally been perfectly clean and healthy, and foul material may gain entrance to it later, and convert it into a poisoned wound. This may happen in an infinite variety of ways. A person with a wound upon the hands, however slight, who handled a foul sore or ulcer without precaution or came into contact with unhealthy discharges would run great risk. Similarly anyone who had dressed or assisted in dressing unhealthy wounds or sores of one person, and went straight to assist in the dressing of another person who had a perfectly clean and healthy wound, would be almost certain to infect the clean wound with material from the unhealthy one. Surgeons are now exceedingly careful and scrupulous in this respect, and adopt all manner of precautions, not only to ensure the thorough cleanliness of their hands and instruments, but also to ensure that their clothing may not be a source of danger. It is surprising how small a wound, a mere scratch and mere prick with a pin or needle, may offer sufficient entrance room to foul material. The author was awakened one night by pain and throbbing of his right thumb. By morning the whole thumb was red, swollen and tender, and a broad pink band of inflammation passed from the thumb over the wrist and up the front of the arm to the inner side of the elbow, where happily it stopped. This was acute inflammation of lymphatic vessels (see p. 206), due to a poisoned wound, but there was neither wound nor scratch apparent. But after a little thought the cause was clearly traced. He had accidentally pricked his thumb with a pin, a perfectly clean and harmless pin. But an hour or two later he had to treat at a public dispensary a large number of cases of eye disease, including several cases of a form of inflammation attended by copious discharge of a very contagious character from the eyelids. During the holding open of the lids with the thumb and forefinger, some of the infective material had crept into the minute and forgotten pin-prick, and though, immediately after the case had been treated, the hands had been carefully disinfected and washed, still enough had gained entrance to give trouble, though fortunately only for a few days. No one, then, can be too careful in dealing with foul sores or discharges, and no scratch or broken skin, however small, is so insignificant as not to need protection in the presence of such unhealthy wounds.

Some persons seem to be peculiarly invulnerable to risks of this description, while other persons are peculiarly liable. Undoubtedly also the tissues of some persons resist the operation of such morbid material more strenuously than those of others; and it is equally certain that the state of one's health at the time affects in a very marked way the degree of resisting power. Thus a person in depressed general health is much more apt to be affected by poisoning in a wound than another in robust health.

The symptoms that attend poisoning in a wound are redness, pain, and swelling in and around the wound, with the formation of matter, and perhaps the death and separation of some part of the tissues. Then the redness extends along the lines of the lymphatic vessels leading from the site of the wound up the limb, and these vessels are marked out by fine red lines, which, as the inflammation extends, become broader and merge in one another. These lines meet in the nearest gland, which may become inflamed and swollen also, and be hard and tender, and may end in becoming a collection of matter. Here the process may cease, but on the other hand, it may continue its course up the limb, and produce attacks of shivering, fever, and all the symptoms of blood poisoning, which need not be detailed here, since they have been discussed on p. 236. Reference also to p. 206 and p. 207 will explain the effects on lymphatic vessels and glands.

The Treatment of Poisoned Wounds.—In the first place what is to be done when a wound is received from an instrument known to be foul? It should be immediately thoroughly washed with a stream of clean water. If carbolic acid is at hand, or Condy's fluid, it should be added to the water. The corrosive sublimate solution (p. 912), supposing it to be at hand, would be the most useful. But in most cases some delay is inevitable, and meanwhile the

poison would be absorbed. Therefore the speediest method, and one always at hand, is to grip the part immediately above the wound as tightly as is possible, to arrest the circulation, and vigorously suck the wound with the mouth to remove the poison. As soon as possible thereafter it should be washed. Further to ensure destruction of the poison the wound should be touched all over its surface with lunar caustic (nitrate of silver). It should then be covered with a piece of lint smeared with vaseline, or carbolized vaseline, or soaked in carbolic oil. The lunar caustic destroys only a fine surface film of the tissue, and when this has separated a healthy wound is left. If any of the strong acids, nitric, for example, be at hand, it may be employed instead of the caustic. But this agent is so destructive that it must be applied with great care. The best way is to dip a piece of wood, the end of a match, if nothing better can be had, into the acid, shake off the drop that adheres and then pass the end lightly over the surface of the wound, care being taken not to touch any of the uninjured skin. The wound is then bathed with cold water and bound up as before advised. Another very effective method is to heat to *a white heat* the end of a knitting needle, or failing anything better, the end of a long nail, and pass it over the whole surface of the wound, then apply cold water dressing to subdue inflammation, and frequently renew it. If the iron be heated to a white heat the pain inflicted by the application is comparatively trifling.

In the event of a wound, believed at first to be quite clean, showing signs of having been poisoned, the dressing must be immediately undone. If a pustule or boil or abscess has formed, it should be freely laid open by a sharp knife, and every particle of matter cleared out, and the wound thoroughly mopped out with carbolic or other antiseptic lotion (p. 912). The raw surface might then be touched all over with caustic or strong carbolic acid, or other acid, washed again in a stream of cold water and then dressed as already suggested. Frequent antiseptic cleansing would be afterwards necessary. Treatment of further complications is sufficiently explained under the headings of blood poisoning and inflammation of lymphatic vessels and glands (pp. 236 and 206).

Now although these directions have been given to meet emergencies, and the case of those who are out of reach of medical aid, the consequences that may ensue are so grave, and their treatment requires so much constant care and skill and knowledge, that no delay should be allowed to take place and no trouble spared in obtaining competent medical aid.

Stings of Insects.—Bees and wasps are in this country and in America the insects which have the greatest number of victims by their stings. It is quite a common thing in summer to see recorded the narrow escape of a person from being stung to death, and now and again actual death of an adult or child. As regards bees these accidents seem to be most common about the time of the casting off of a swarm, and numerous are the instances reported of a swarm settling on a person's head, and being skilfully "hived" without the slightest injury to the person. Thus we take the following story of an old English bee-master, Thorley, as an illustration. "In the year 1717, one of my swarms settled among the close-twisted branches of a codling tree, and not to be got into a hive without help. My maid-servant being in the garden, offered her assistance to hold the hive while I dislodged the bees. Having never been acquainted with bees, she put a linen cloth over her head and shoulders to secure her from their stings. A few of the bees fell into the hive, and some upon the ground, but the main body upon the cloth which covered her garments. I took the hive out of her hands, when she cried out that the bees were got under the covering, and were crowding up towards her breast and face, which put her into a trembling posture. When I perceived the veil was of no further service, she gave me leave to remove it; this done, a most affecting spectacle presented itself to the view of all the company, filling me with the deepest distress and concern, as I thought myself the unhappy instrument of drawing her into so imminent hazard of her life. Had she enraged them all resistance would have been vain, and nothing less than her life would have atoned for the offence. I spared not to use all the arguments I could think of, and used the most affectionate entreaties, begging her with all the earnestness in my power to stand her ground, and keep her present posture; in order to which I gave her encouragement to hope for a full discharge from her disagreeable companions. I began to search among them for the queen, they having now got in a great body upon her breast, about her neck, and up to her chin. I immediately seized her, taking her from the crowd, with some of the commons in company with her, and put them together into the hive. Here I watched her for some time, and as I did not observe that she came out, I conceived an expectation of

seeing the whole body quickly abandon their settlement; but instead of that, I soon observed them gathering closer together without the least signal for departing. Upon this I immediately reflected that either there must be another sovereign, or that the same was returned. I directly commenced a second search, and in a short time, with a most agreeable surprise, found a second, or the same. She strove, by entering farther into the crowd, to escape me; but I re-conducted her, with a great number of the populace, into the hive. And now the melancholy scene began to change to one infinitely more agreeable and pleasant. The bees, missing their queen, began to dislodge and repair to the hive, crowding into it in multitudes, and in the greatest hurry imaginable; and in the space of two or three minutes, the maid had not a single bee about her, neither had she so much as one sting—a small number of which would have quickly stopped her breath." The queen-bee, it may not be out of place to remark, is distinguished from the others by the considerably greater length of body, the upper portion being of a deeper black than that of the workers, while the under surface and the limbs are of a rich tawny colour. The legs are longer, but without hairy brushes at the joints; the proboscis is more slender, and the hinder pair of legs are without the cavity possessed by the others for collecting farina. In the breeding season the body is greatly swollen and elongated. The notable point of the above story is the harmlessness of the bees during the swarming season, when they are intent upon following the queen-bee, provided they are not excited or enraged by being injured or crushed. Many people directly court attack from bees and wasps by the wild state of excitement into which they allow themselves to be thrown by the approach of an insect, and the frantic efforts they make to get at it with a handkerchief, or to drive it off. Much less risk is run if the person will quietly move off, and at anyrate forbear exciting the insect by such means.

Many persons are peculiarly susceptible to the sting of bee, or wasp, or other insect, the part bitten becoming speedily inflamed, much swollen, and painful. Others again are much more tolerant. A single sting on the eyelid, or in its immediate neighbourhood, will, in susceptible persons, soon cause so much swelling that the eye is closed up. Death has resulted in such persons from a single sting. Cases of stinging in the throat have occurred, death arising from suffocation by the great swelling occasioned. Death is usually due, however, rather to the shock of numerous stings and the collapse they produce.

The treatment of such stings is similar to that for much more serious insect stings, snake bites, &c. In the case of the bees and wasps the sting is often broken off and left in the wound. It should be immediately removed with fine tweezers, and then some alkaline remedy is applied to destroy the acid character of the poison introduced. Lime, chalk, baking soda, moistened with water, are all useful and materially diminish the pain. Even loam is useful. But best of all is ammonia water (hartshorn) or aromatic spirit of ammonia freely applied. A popular and very useful remedy is the leaf of the common dock, bruised, the juice being rubbed into the wound, after withdrawing the sting, for ten or fifteen minutes. A poultice of ipecacuanha is believed by some to be an antidote for every kind of poisonous bites. Cold water applications continuously applied for some time will relieve the pain and diminish the swelling. Olive-oil, vinegar, laudanum, are also recommended, or a lotion of a tea-spoonful of sugar of lead dissolved in a tea-cupful of cold water. If the throat is stung the sting should be removed if possible. Fifteen drops of ammonia water, well diluted, may be given to sip, and repeated in a quarter of an hour, ice to suck, warm water and salt with which to gargle the throat, and cloths wrung out of hot vinegar and water are wrapped round the neck. If the swelling threatens suffocation a surgeon would lessen its amount by scarification, while if the shock is great other stimulants are necessary, hot whisky, or brandy and water, along with 20 drops of laudanum, repeated in an hour, if needful, to diminish the pain. In such cases the opening of the windpipe—tracheotomy—might be necessary to permit of breathing.

The Mosquito is another common pest of warm climates. Its bite is inflicted by a long lancet-like organ of six bristles, folded together in a grooved sheath. After the bristles penetrate the skin the blood is drawn by the channel found between them. The treatment is the same as for the sting of the bee or wasp.

The Chigoe (*Pulex penetrans*) (Fig. 370), Chique, Pique, Bicho, or Jigger is very common in the West Indies and tropical America. It attacks the feet, the female burrowing beneath the skin, and forming a little cyst in which it lives until the body is distended with eggs. The small swelling is then of the size of a pea and

of a bluish colour, and it occasions violent itching. It penetrates chiefly under the nails. The cyst can be extracted entire with the point of a needle by those expert at it; but if it is broken and the young escape severe inflammation arises. The means of prevention is constant cleanliness, and the wearing of covering on the feet whether in or out of doors.

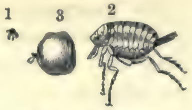


Fig. 370.—Chigoe.

1, male chigoe of the natural size; 2, the same magnified; 3, a female full of eggs, natural size, as taken from a human toe.

Ticks of many varieties abound in the tropics. They bury the head under the skin and suck the blood in that position. When the body is pulled away the head is usually left, and should be extracted with tweezers; nicking the skin with a sharp knife aids the process. The use of very hot water aids their removal, lessening the risk of breaking off the head.

Midges are a common pest, and on some people produce much swelling and painful itching. Whisky is often applied to the skin to relieve the pain, and those whose face readily becomes swollen find much benefit by laying a piece of cloth soaked in the whisky over the skin. An ointment made of 60 drops oil of pennyroyal to one ounce of vaseline, lard, or other simple ointment, smeared on the face is a useful preventive. Equal parts of wood tar and sweet-oil are also used to smear exposed parts. Camphor and lemon juice are also used; and carbolic acid sprinkled freely about a room prevents their attack. But mosquito curtains well arranged are a necessity. Those who camp out use a smouldering fire of green wood, placed where the smoke is blown about the tents, as a prevention to attacks both of midges and mosquitoes.

Bed-bugs (*Cimex lectularius*) are not easy to dislodge when they gain a footing in a wooden bed. One of the best applications is a mixture of three parts petroleum and one hundred parts of water. This is applied to all cracks and crevices of woodwork. Beds should be scalded with boiling water. Fumigation with sulphur is an effectual remedy. Bed-bugs are said not to venture from their corners except in the dark, and that if even a feeble light be kept burning in a room all night they will keep in confinement.

Spiders of various kinds are also very obnoxious. There is the black spider of the northern parts of America, whose bite causes sometimes much pain and inflammation, and the **Tarantula** of the south-west, a large spider capable of inflicting a severe bite, which may be followed by severe shock and inflammation. Such bites are to be treated in the way recommended for the stings of bees, ammonia lotion and a poultice of ipecacuanha specially being recommended.

The Scorpion and Centipede are common in the southern states of America, and in Asia and Africa; and they there attain a large size, the latter often being from five to seven inches long. The scorpion belongs to the spider class; and carries its sting as a hooked claw prolonged from the abdomen. At the base of the claw is the poison gland, a fine channel running to the point. In the latter the offensive weapon is part of the jaws, hooked in form, and perforated with a fine canal for the discharge of the poison. The bites of these animals are often very severe, causing serious inflammation, great depression of vital powers, and much collapse. They are to be treated in the same way as stings of bees and wasps, ammonia and whisky being applied to the part, and stimulants given internally. To remove the poison from the wound small incisions are made and encouraged to bleed, and the wound may be sucked, if no scratch exists on the lips or mouth. The use of cupping glasses after scarification is also recommended.

The Guinea-worm (*Dracunculus* or *Filaria medinensis*) is in one stage a minute animal inhabiting water or moist soil, and common in the East Indies and on the coast of Africa. It attacks those exposed to it owing to bare feet and legs, pierces the skin and then proceeds to develop the worm form in the loose tissue. It is the female only that is known. In this situation it grows to a length varying from one to six feet, of the thickness of vermicelli, and it reaches its maturity, when its body is filled with eggs, in about nine months. Much pain, stiffness, and swelling accompany its growth, and finally a large bleb filled with fluid rises on the skin, usually in summer. When the raised

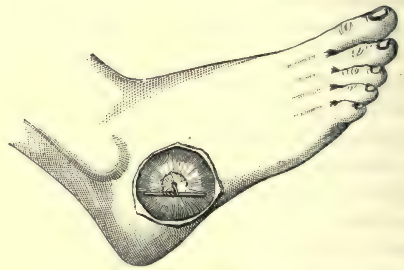


Fig. 371. Mode of Extraction of Guinea-worm.

cuticle has been removed, the head and an inch or more of the body of the worm are seen projecting from the centre of the raw surface. An abscess may be formed, and when it is opened the head of the worm is found. It is removed only gradually by twisting the fine end of the worm round a piece of adhesive plaster, rolled into a quill shape, or round a piece of wood such as a match, and then every day a turn or two is given to the plaster or match, the worm being gradually wound upon it, no violence being used lest the body be torn (Fig. 371). After a more or less prolonged period the tail of the worm is reached, recognized by its hook-like appearance.

Snake-bites.—All snakes and serpents are not venomous, though all are capable of biting. One of the main distinctions between those that are poisonous and those not so is that the poisonous reptile, as a rule, has no ordinary teeth in the upper jaw, but has instead two long curved conical fangs. These fangs, when not in use, may be concealed in folds of the lining membrane, but when the jaw is opened they are erected to strike. Connected with each fang is the poison gland, one of the glands of the mouth, which has undergone special development, and a duct from the gland passes to the fang, which is perforated to the point by a fine channel down which the poison can be discharged, when the animal strikes. Behind these upper jaw-bones the palate bones carry a row of teeth, fitted for seizing and holding or squeezing prey, but not for chewing. In non-poisonous reptiles the poison fangs are not present, but there is a row of teeth in the ordinary position in the upper jaw, and rows of the palatine teeth behind them. Fig. 372 shows the head of a venomous snake —a viper, while Fig. 373 shows the head of the British snake, which is destitute of these fangs, and is therefore harmless. The forked tongue seen protruding from the mouth in each case is not capable of doing harm. It is formed by two muscular cylinders united towards their base but free at their extremities, and used rather as an organ of touch than of taste.

Fig. 372.
Head of Poisonous Snake.

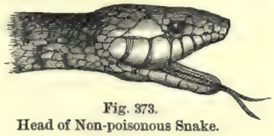


Fig. 373.
Head of Non-poisonous Snake.

Among the non-venomous snakes are the common **ringed snake** of Britain, already mentioned, the **black snake** (*Bascanion constrictor*), and the **pythons** and **boas**, which include the kinds popularly known in America as the **anaconda.** These latter, all belonging to the boa family, include the largest and most powerful animals of the serpent species. Though their bite is harmless they are very destructive, because of their power of winding themselves round the bodies of their victims and crushing them into pulp in their coils, preparatory to swallowing them.

To the venomous serpents belong the **common viper,** occurring in England and Scotland, which inflicts a severe bite, but not commonly deadly except in the case of children and feeble persons, and the American **rattlesnake** (*Crotalus horridus*), which is very deadly. The rattle is due to a series of horny scales, jointed to one another, at the end of the tail, the shaking of which, when the animal throws itself into a coil, makes the noise. The **water viper** or **moccasin** (*Cenchris* or *Ancistrodon piscivorus*), found in swamps in warmer parts of America, the **copperhead** (*Trigonocephalus contortrix*), the **cotton-mouth** (perhaps a variety of the copperhead), and the **harlequin-snake** (*Elaps fulvius*), are all venomous and found in America. In Brazil and Central America is found a poisonous variety, of the same species as the rattlesnake, and called the **jararaca**; in Australia the **tiger-snake** and **death-adder** (*Acanthophis tortor*) are venomous; in Africa the **horned-snake** (*Cerastes cornutus*) and **puff-adder** (*Clotho arietans*) of the Cape of Good Hope, and the **asp** (*Naje haje*) are the best known and most dreaded. In India, where it is calculated 20,000 natives die annually from snake-bite, the chief poisonous serpents are the **cobra,** cobra-di-capello (*Naja tripudians*), the **bungarus** or **rock-serpent, Russell's viper** (*Daboia*), chain-viper or tic polonga of Ceylon, and the *Ophiophagus Elaps.*

The cobra is also called hooded or spectacled snake, because the skin of the neck is very loose, and can be distended to cover the neck like a hood, while the ocelli on the back of the neck produce the spectacled appearance.

Besides those named, poisonous sea-snakes abound in the Indian and Pacific Oceans.

The effects of a snake-bite, as well as those of stings, depend on the amount of poison injected into a wound. This is not the case with poisoned wounds, such as dissection wounds, wounds poisoned by putrefactive material. The poison injected in the case of the snake-bite is not capable of multiplying in the system. It contains an alkaloid, according to some, acting by

chemical activity. If one has been thoroughly bitten, a double wound should be seen, the punctures of the two fangs, half an inch apart. Intense pain and swelling occur at the bitten part, extending up the body. Symptoms of shock quickly come on, giddiness, loss of speech, clammy sweats, dimness of vision, faintness, weakness, sickness and vomiting. Drowsiness, stupor, unconsciousness, and perhaps convulsions occur. Death occurs generally within two hours, but may be more speedy, and death is almost certain if a full dose of poison has been injected by the animal. But if a small dose of the poison has been received, or the venom is inert from some condition of the serpent, recovery may ensue, even after threatening symptoms have been shown.

Treatment of Snake-bite is thus laid down by one of the greatest authorities on Indian poisonous serpents, Sir Joseph Fayrer: "When a person is bitten by a poisonous snake, send at once for the doctor. Pending his arrival, apply a ligature, made of a piece of cord, round the limb or part at or about 2 or 3 inches above the bite. Introduce a piece of stick or other lever between the cord and part, and by twisting tighten the ligature to the utmost. Apply two or three ligatures above the first at intervals of 4 or 6 inches, and tighten them also. After the ligatures have been applied, scarify by cutting across the puncture to the depth of ¼ inch, with a sharp penknife or other cutting instrument, and let the wounds bleed freely, or better still, excise the punctured and poisoned part. Apply either a hot iron or live coal to the bottom of these wounds as quickly as possible, or some carbolic or nitric acid. If the bite be not on a finger or toe, or on a part where the ligature can be applied, raise up the integument with the finger and thumb, and with a sharp penknife cut out a circular piece as big as a finger nail round each puncture, that is, round the points of the finger and thumb, to the depth of ¼ inch. Then apply the hot iron to the bottom of the wounds, and wash the part with solution of permanganate of potash. Give fifteen drops of liquor ammonia, diluted with water, immediately, and repeat it every quarter of an hour, for three or four doses or longer, if symptoms of poisoning appear, or give hot brandy or other spirit, with an equal quantity of water, about an ounce of each for an adult, at the same intervals. Should no symptoms of poisoning come on in half an hour the ligatures should be relaxed, or the part will perish from gangrene. If depression, faintness, nausea, hurried respiration, and exhaustion supervene, the ligature should not be relaxed until the person is recovering, or until the ligatured part is cold and livid.

Another plan lately introduced by M. de Lacerda is not to scarify, excise, and cauterize, &c., but to inject into the site of the bite a 1 per cent filtered solution of permanganate of potash, the object being to follow up and neutralize the poison. If by this method a sufficient quantity of the antidote could be accurately brought into contact with all the virus in the tissues (the mixture of snake poison and solution of permanganate of potash out of the body, when injected under the skin, is quite innocuous) it might prove an effectual remedy; and we are glad to observe that Mr. Richards is zealously prosecuting a series of experiments, with a view to determine the value of the practice.

Sucking the wounds may be beneficial, but as it may be dangerous to the operator it cannot be enjoined as a duty. If, however, it be practised, rinse the mouth thoroughly both before and after the procedure, with the permanganate of potash solution. If symptoms of poisoning set in and increase, if the patient become faint or depressed, unconscious, nauseated, or sick, apply mustard poultices or liquid ammonia on a cloth over the stomach or heart; continue the stimulants, and keep him warm, but do not shut him up in a hot stifling room or small native hut; rather leave him in the fresh air. Do not make him walk about if depressed; nurse him with stimulants, mustard poultices or ammonia, but let him rest. If the person be seen some time after the bite has been inflicted, and indications of poisoning are present, the same measures are to be resorted to, or the new method of M. de Lacerda may be adopted. They are less likely to be successful at this late period of the case, but nothing else can be done. In many cases the prostration is due to fear; the bite may have been that of a harmless or exhausted snake, and persons thus bitten will, of course, rapidly recover under the use of the above measures. If poisoned, but, as is frequently the case, not fatally, these measures are also the most expedient; if severely poisoned, no others are likely to be more efficacious. People should be warned against incantations, popular antidotes, and loss of time in seeking for skilled aid. The remedial means suggested are no doubt severe, and not such as under other circumstances should be intrusted to non-professional persons; but the alternative is so dreadful, that, even at the risk of unskilful treatment, it is

better that the patient should have a chance of recovery."

The two objects of this treatment are, first, to remove the poison before it can get into the circulation, if possible; and second, to maintain the strength of the patient by stimulants till any poison that has gained entrance to the blood is expelled by the ordinary excretory channels. For the latter purpose whisky is much relied on, and is given at frequent intervals, even to the point of symptoms of intoxication beginning to show themselves. Under the circumstances, however, very large quantities can be given without intoxication being induced; but it is needful to observe that that condition is not desired.

Bites of other Animals.—Hydrophobia is the only disease requiring mention as resulting from the bites of dogs, cats, foxes, &c., and it has been discussed on p. 421.

The Poison of Venereal Disease.—There is one disease of this class, due undoubtedly to a special poison, which has been already described elsewhere (p. 422). There are other two affections, occasioned also by the introduction into the body of morbid material, but whether they are as truly the result of specific poisons is not so certain. The one is **soft chancre**, chancroid ulcer, or the soft sore, so called in contradistinction to the hard sore, which is the first step in the production of syphilis; the other is an inflammation of the urinary passage, called **urethritis or gonorrhœa.** The soft chancre is a simple ulcer, with a ragged irregular floor, with an abundant yellow discharge; and the tissues beneath it are not condensed and hardened as in the other variety; but, though they may be puffy and swollen, are of the natural softness and mobility. This ulcer tends to worm its way in every direction under the skin and to produce much destruction of parts. Moreover the matter from the ulcer readily produces other ulcers on the same person. This sore appears first simply as a small red inflamed area, where the poison has penetrated. In two or three days it is a pimple and the skin around it is inflamed. In another day it is a bleb filled with clear fluid, which, however, becomes yellow; and when about the sixth day the pustule bursts, the ulcer is the result. It is capable of invading the tissues in every direction and producing extensive loss of substance. There is often considerable surrounding inflammation and pain. Moreover, some of the matter from the ulcer may be picked up by absorbent vessels and carried to the chain of glands in the groin (*d*, *e*, *f*, Fig. 113, p. 208), leading to the inflammation and suppuration of one or more of the glands. This is called a **bubo**. If it actually comes to matter, and is allowed to take its course and burst, then a large ragged foul sore is produced, pouring out a profuse discharge, and the matter of this ulcer is capable of producing a new one on parts with which it comes into contact, just as the matter of the original sore. It is, if not promptly and vigorously treated, almost certain to spread along the groin, invading one gland after another, till a large irregular ulcer is produced. Even although material is not carried up to the glands of the groin infecting them, a bubo may arise owing merely to the irritation. This is called a **sympathetic bubo.** It is simpler and more easily dealt with than the former, but may end in the formation of an abscess. The indications of the formation of a bubo are redness, heat, pain, and swelling in the groin. When matter forms the swelling becomes soft, and it points, and soon, if not opened, bursts the skin.

The **treatment** of the soft chancre and such complications as may arise ought always to be in the hands of a surgeon. So much mischief may be produced by neglect, and so much destruction of tissue may rapidly occur, that the sooner the case is dealt with by a competent person the better. The first thing one seeks to do is to destroy the poisonous character of the sore. One of the most effectual ways is by means of strong nitric acid. The sore is wiped clean and dry with lint. A piece of lint in a basin of cold water is placed at hand, then a small piece of wood—the end of a wooden match will suit—is dipped into the acid, any hanging drop is removed against the lip of the bottle, and the piece of wood is passed over the whole surface rapidly, and excess is removed by the use of the wet lint. A white film forms immediately over the sore, due to destruction of the surface. In a day or two this falls off, leaving a healthy surface, discharging healthy matter, and showing the red granulations of a healing wound (p. 968). If the whole surface of the sore has not been touched with the acid it will remain discharging infective material and undermining the skin, reinfecting the healthy portion. It is, therefore, needful to make certain that the acid has been applied over the whole surface, the undermined edges of the skin being specially attended to. If in a day or so the sore seems extending in some directions and healing in others, one may conclude

that the application of the acid has not been thorough enough, and it may then be reapplied. Instead of nitric acid carbolic acid might be used.

After the excess of acid has been removed by the wet lint the part should be dried, iodoform should be dusted over it, and a piece of antiseptic cotton lightly fixed upon it. Twice a day, at any rate, the dressing should be removed, the part carefully washed with hot water, dried, and fresh iodoform and dressing reapplied. Carbolic lotion or chloride of zinc lotion might be used instead of the iodoform, or sulpho-carbolate of zinc lotion (see Section IX., p. 910), the strong penetrating smell of iodoform is so unpleasant. If any of these is used a pledget of lint is soaked in it, placed over the sore, covered with oiled silk, then with a larger piece of antiseptic wool and lightly secured with a bandage.

It should be noted that scrupulous care must be exercised in washing the hands after performing such a dressing, and in burning all particles of lint, cotton, &c., that have been used. No towels should be employed, but only pieces of lint, &c., that can readily be burned. All this is to prevent infection of others.

When a bubo is threatened the person should immediately take up a reclining position and keep at perfect rest, since motion only aggravates the pain and swelling. Then cloths, lightly wrung out of iced water, should be placed over the part and renewed every few minutes for half an hour or so on end. After two or three hours' interval this process may be repeated. If the pain and swelling begin to subside, this treatment should be persevered in, the ice, however, never being so long applied continuously as to produce a livid appearance on the part. If, however, the swelling increases and becomes soft, it is clear matter has formed, or is forming, the ice is to be abandoned and warm applications employed. At the very earliest moment the abscess should be opened, for if this be not done the matter may burrow in all directions and effect much destruction. If the abscess be a simple one it is enough to keep it clean by frequent bathing and to apply simple dressings of some antiseptic solution and antiseptic cotton. If, however, it is an abscess produced by absorption of the poison of the original sore, it will, like it, exhibit highly destructive tendencies, and will require to be treated on the same lines as the original chancre.

Throughout all this treatment the person should take light opening medicines of the saline kind (p. 862). should have a plain but wholesome and nourishing diet, and should avoid all spirituous liquors. Complete rest is almost a necessity.

Urethritis or Gonorrhœa is an inflammation of the urinary passage, which may be occasioned by mechanical or chemical irritation, the passing of a catheter or stone, by contact with discharges of a perfectly innocent character, such as that of leucorrhœa (the whites), but which is most commonly due to impurity. But the fact that it may arise in a perfectly innocent way must never be overlooked. In cases due to contagion the first symptoms occur in four or five days, though they may arise sooner or later. They consist in a feeling of itching at the orifice of the canal, a feeling of heat or slight scalding in passing water, a slight thin discharge, and some degree of redness and pouting at the opening of the canal. Within twenty-four or forty-eight hours acute inflammation has developed, the redness and swelling are much increased, the scalding is great, the discharge is copious and white or yellowish white, and there may be frequent desire to pass water, only small quantities coming with difficulty and with much pain. Painful erections (**Chordee**) occur specially during the night. This condition of affairs lasts for several days, or for fully a week, and then the symptoms begin to abate. The pain, &c., diminishes and disappears, and the discharge becomes thin and watery and scanty, and may speedily cease. A thin and scanty discharge may, however, persist for a long period—termed a **Gleet**. There are numerous complications which may occur. Inflammation may extend to the testicle or bladder, and very commonly to one of the glands of the groin, ending in a bubo (see p. 987), which, however, is more easily subdued than that due to soft chancre. Two other complications of gonorrhœa are gonorrhœal rheumatism and an inflammation of the eyes, exactly resembling that described on p. 458 as purulent inflammation of the eyes of the newly born. The treatment of gonorrhœa to be successful depends upon so many details, if it is speedily to effect the cure of the inflammation and prevent it becoming chronic, that it is hardly possible for it to be treated successfully except by a skilled person. The general lines of treatment may, however, be indicated. First of all physical exertion should be avoided, absolutely if possible; the bowels should be unloaded by a brisk saline medicine, such as salts or seidlitz-powder; the diet should consist of skimmed milk as largely as may be, at any rate all fat, highly seasoned dishes, pastries,

pepper, acid substances and fruits being carefully refused, and very specially all alcoholic drinks whatever being denied. Abundance of soda or potash water, apollinaris, or seltzer, may be drunk alone or with milk, as well as ordinary water. These dilute the urine and diminish its irritating characters. To still further diminish the acidity of the urine, to increase the quantity of water passed in order to flush the canal, and to relieve pain, the following mixture is taken in table-spoonful doses every two hours:—

Bromide of potassium,...............	160 grains.
Acetate of potassium, ...	4 drachms.
Infusion of pareira brava, or infusion of buchu,.....................	8 ounces.

Mix.

If the pain and chordee are great, 4 drops of tincture of belladonna may be added to each alternate dose. The part should be kept perfectly clean, but not enveloped in a mass of material, a thin layer of absorbent cotton only being used to absorb the discharge, and fixed by being lightly rolled round the point of the organ and secured by the foreskin being drawn forwards over it. It must be frequently renewed. If the chordee be severe, full doses of bromide of potassium—30 grains in each dose—should be given several times during the day, and along with 5 to 8 drops of tincture of belladonna at bed-time. A morphia suppository ($\frac{1}{2}$ grain) may be passed up into the bowel at bed-time. If so, however, care must be taken to secure free movement of the bowels by a seidlitz-powder early next morning. In many cases the symptoms subside without further treatment. Should they not disappear, but the disease pass through all its stages, injections need to be resorted to, but they are not to be employed during the inflammatory process, but only after the inflammatory symptoms have declined, after the first eight or ten days. When this stage is reached, the simplest injection is that of sulphate of zinc, 2 grains to each ounce. It is at this stage also that, for the first mixture, one containing cubebs and copaiba is substituted. Perhaps the simplest form is that of capsules containing 20 drops each of oil of cubebs and copaiba, of which two to four are taken three or four times daily, or instead 10 drops of sandal-wood oil on a piece of sugar three or four times daily, or 20 drops of copaiba with 20 of liquor potassæ and an ounce and a half of water may be taken thrice daily. Such treatment ought to be sufficient to effect a cure; but it must be remembered that a modified form of the inflammation may readily recur with a slight exciting cause, and great care and moderation in eating, drinking, and in other habits will be necessary to confirm the cure. The manner of giving the injection is of the utmost importance, since unless the injection fluid be brought into contact with all of the inflamed membrane of the canal no benefit can be expected. The patient should have a glass syringe, capable of holding one ounce. It should be provided with a bulbous end. When the syringe has been completely filled with the injection fluid and all air expelled, the bulbous end is introduced into the canal, the organ being held upright with the left fore-finger and thumb. The mouth of the canal is pressed against the syringe to prevent any fluid escaping; and the piston of the syringe is slowly pressed down till the canal is full. When the syringe is withdrawn the person must compress the mouth of the canal with finger and thumb for two or three minutes, to retain the fluid. When the person lets go, the fluid is immediately ejected by the elasticity of the canal. Before the injection is given the patient should pass water to wash any matter out of the canal, and prevent it being driven up into the bladder by the injection. Instead of the sulphate of zinc, sulpho-carbolate of zinc may be used in solution, 1 grain to each ounce of water, or Goulard's water. Chronic forms of the disease it is needless to consider here, nor yet cases of gonorrhœal rheumatism or ophthalmia, which must have expert treatment. Complete rest and the use of saline opening medicines and the application of iced cloths, as suggested on p. 988, will often arrest a threatened bubo or inflammation of the testicle. In the latter case a suspensory bandage to relieve the parts of dragging is essential.

Section III.

SHOCK OR COLLAPSE AND SYNCOPE OR FAINTING AND INSENSIBILITY: THEIR TREATMENT. THE TEMPORARY TREATMENT OF FRACTURES. THE CARRIAGE OF INJURED PERSONS.

Shock or Collapse:
- *Its Nature and Treatment*—Syncope or Fainting;
- *Reaction and Traumatic Fever;*
- *Insensibility or Unconsciousness.*

The Temporary Treatment of Fractures:
- *The General Signs of Fracture;*
- *Temporary Treatment of Broken Collar-bone;*
- *Temporary Treatment of Broken Upper Arm;*
- *Temporary Treatment of Broken Forearm;*
- *Temporary Treatment of Broken Thigh-bone;*
- *Temporary Treatment of Broken Lower Leg;*
- *Temporary Treatment of Broken Ribs;*
- *Temporary Treatment of Broken Jaw-bone.*

The Carriage of Injured Persons:
- *A Two-handed Seat;*
- *A Three-handed Seat;*
- *A Four-handed Seat*—Queen's Chair;
- *The Use of Forms, Garden Chairs, Settees, &c., for Transport;*
- *Rifle and Blanket Stretcher;*
- *How One Person may Carry an Unconscious Individual.*

SHOCK OR COLLAPSE, AND SYNCOPE: THEIR TREATMENT.

Shock is a state of depression of all the vital powers, following upon some injury or marked mental or emotional impression. The degree and duration of shock are very various, being dependent not only upon the severity of the injury or impression, but also upon the vigour and susceptibility to nervous impressions of the individual. Thus a sudden injury may produce such a profound and paralysing influence upon all the vital powers that death may occur almost immediately or after a brief period. For example, a sudden blow on the pit of the stomach may cause death, due to shock, and after an extensive burn death may occur from collapse in spite of efforts to produce a rally by means of stimulants, &c. On the other hand, an individual may suffer from slight and passing shock, owing, for example, to the receipt of sudden tidings, either joyful or painful, or owing to some slight injury or sudden pain. To take this last instance first, most people know what are its signs—the sudden blanching of the face, the appearance of confusion, the tottering gait, the clutching at a support or sinking into a chair, the trembling that seizes the whole body, the coldness of the hands, indeed of the whole body, the cold clammy sweat that bathes the surface, the sickness, perhaps, and faintness. After a few minutes of anxiety, there is often a prolonged sigh as if some heavy load were being removed, and the colour begins to return; the person begins to rouse himself; and it may be that the momentary depression passes into a brief period of reaction, during which the person's face becomes suffused with a bright flush, and the skin becomes warm and moist. When the shock is more severe, the pallor of the skin remains; the hands and feet are specially cold; the pulse is feeble but quick, sometimes scarcely perceptible at the wrist; the breathing is slow, shallow, and sighing; and the person, though conscious, lies still, with dull eyes, but a strained look upon the face, replies weakly and with effort to any questions, and is, as a rule, entirely indisposed to make any effort either in moving or speaking, while there are indistinctness of vision and confusion of thought. Vomiting may occur and the patient begin to recover, as evidenced by the strengthening of the pulse, the increase in the breathing, the return of blood to the skin and its consequent warmth and moisture. During the period of shock the temperature is invariably below the normal, from a half degree to one and a half or more, and the depression of the temperature is a very good guide to the degree of the shock. If the depression increases, instead of diminishing, all these symptoms become aggravated, the prostration is more marked, weak quick pulse,

feeble imperceptible breathing, and anxious only semi-conscious look upon the countenance; while the pupils are usually dilated, and motions are passed involuntarily from the bowels. Spasmodic muscular twitchings often occur. If, however, the shock is passing off, there are gradual improvement of pulse and breathing, gradual restoration of colour and animation to the face, and gradual restoration of warmth to the surface. The state of depression over, the person passes into a state of **reaction**, with full bounding pulse, quickened breathing, flushed and moist skin, and elevated temperature. This reaction stage usually corresponds, though not always, in duration and degree with the preceding depression. The more severe and prolonged the collapse has been, the more pronounced will be the after reaction. Commonly, however, its signs do not pass much beyond the activity of the normal healthy standard. But after injury or operation it may be so well marked as to become an actually feverish condition; thirst, loss of appetite, foul tongue, constipation, scanty high-coloured urine, excitement and loss of sleep, indicating general disturbance of the functions of the various organs. When reaction goes to this extent, the term **traumatic fever** is applied to it.

In some cases of shock, the patient, instead of being motionless and listless, is restless and excited, tossing about in bed, throwing the arms from side to side and moving the head, in an apparent state of great mental distress. At the same time the other signs of lowered vital powers are to be found, namely pallor, weak pulse, and feeble breathing.

The state of collapse which has been described is usually most severe after injuries involving considerable injury to the tissues or covering an extensive surface. Thus in extensive burns, it is the collapse that is dreaded to begin with rather than the actual injury itself; and it is a most marked feature of injuries accompanied by considerable bruising or crushing of parts, or injuries to bones or joints. The restless form is witnessed when there has been considerable loss of blood, or where there is much pain. Usually, however, in the state of collapse the sensations are much blunted and the patient is not acutely sensible to pain, even sharp pain, but only vaguely conscious of it.

A person may remain in a state of shock for a variable time, from a few minutes to several hours, and this depends not only upon the severity of the injury but also upon the state of the person. For example even trifling accidents produce severe symptoms of shock in persons subject to kidney disease, while women and children and persons of a nervous temperament have rapid and sharp reaction, followed by speedy recovery.

The causes of these symptoms that have been described are no doubt to be referred to the nervous system. In the case of death following a blow on the stomach the fatal result is due to the powerful impression made upon a large mass of nervous substance, called the solar plexus, and connected with the sympathetic system of nerves (see p. 98), which is situated behind the stomach. It is the duty of this system of nerves to preside over the animal functions, the distribution of blood, the action of the heart, the work of the digestive organs, and so on; and any profound impression upon these nerves necessarily affects in a most marked way all these processes. When one, then, considers that it is the effect produced on the nervous system which results in the production of the symptoms that have been described, one can understand how such different things as a sudden joyful surprise, a piece of bad news, a sudden fright, an unlooked-for appearance, or a fall or other injury, may all produce similar effects. The feeble heart, the faint breathing, the cold skin, the vacant mind, the lessened sensibility to pain, are all evidences of unequal and irregular distribution of blood and faint stimulation of the heart, the result of weakened or semi-paralysed nervous influence.

Syncope is a condition akin to shock in its nature and cause. It is sudden and profound and caused by arrest of the heart's action. It may occur because of sudden emotion or fright, or because of pain, or loss of blood. It has been already described on p. 243.

The Treatment of Shock.—In the very slight cases of shock little or no treatment is required. The person should be made to sit down or recline, and the application of smelling-salts to the nostrils, the administration of a tea-spoonful of aromatic spirits of ammonia (sal volatile) in water, or any hot drink, will usually be sufficient. This is practically the same treatment as has been already described for fainting on p. 243. In the case of severe shock, however, much more is necessary. A consideration of the real nature of the attack will clearly show that the two chief objects to be sought in treatment are the restoration of the warmth of the body and of the activity of the circulation. Both of these objects are obtained by the same treatment. The person is to be laid on a bed or couch and the clothes are

to be quickly removed, the usual night garments being substituted. Hot-water bottles should be placed at the feet, or hot bricks wrapped up in flannel. It is needful to warn against placing a bottle filled with boiling water against the patient's body unprotected from excessive heat. For, in the state of diminished sensibility of the patient, actual burning of the skin might occur without the person experiencing pain. A very severe case of this sort came once under the author's treatment. If the coldness of the body is extreme and the prostration great, the patient may be wholly wrapped in warm blankets, and hot-water bottles placed outside the blankets to maintain their warmth. In such extreme cases, also, flannels wrung out of hot mustard and water (a table-spoonful of mustard to a pint of hot water) should be placed over the chest and belly, and specially over the heart, and these may be frequently renewed. Or a mustard poultice may be applied, or a cloth sprinkled with turpentine and then covered over with a thick flannel pad wrung out of hot water. Meanwhile, any assistants may be occupied rubbing the limbs from their extremity upwards. This should be done without exposing the parts to further cold. In the next place stimulants are to be given by the mouth, if the person can swallow. Whisky or brandy in hot water is undoubtedly the best. Two or three tea-spoonfuls of the spirit in half a wine-glassful of hot water may be given at once, and this may be repeated in twenty minutes or half an hour, if needful. It may be repeated at brief intervals several times, the pulse being taken as an indication of its need; but excitable people are apt to administer large quantities in their terrified zeal; and this must be guarded against. Strong hot coffee or tea is also useful if an alcoholic stimulant be not at hand. Instead of any of these, ammonia, either in the form of the weak spirit of hartshorn (10 to 15 drops in water) or in the form of the aromatic spirit (half to one tea-spoonful in water), may be given by the mouth and frequently repeated. Small quantities of hot beef-tea—a wine-glassful at a time—are also useful, frequently repeated. If the person cannot swallow, the stimulant—whether of whisky and water or milk, brandy and water or milk, or wine and water, or ammonia and water—should be injected into the bowel. Severe cases of shock, and the shock of snake bite, have been treated successfully by the injection *into a vein* of 10 drops of the spirit of hartshorn in 1 or 2 ounces of warm water. This could only be undertaken by a medical man, but the same quantities could be injected into the bowel without risk by anyone. Ether—sulphuric ether—is often employed to produce a rally in profound prostration after injury or loss of blood—10 to 30 drops may be injected under the skin by means of the hypodermic syringe. It acts with great rapidity. All these measures are not necessary except in most extreme cases. In ordinary cases, in which the circulation is restored in from half an hour to two or three hours, the warmth to the body, friction, and the hot stimulant are quite sufficient. Provided the pulse is gradually improving it is a mistake to be too officious. Someone requires to "stand by," and give occasionally another small dose of the stimulant, for in such cases the patient is quite conscious and able to swallow. By being too energetic one is apt to encourage an excessive reaction and some amount of fever. Should such undue reaction occur iced cloths may be applied to the head, stimulants are to be stopped, diet is to be kept low, and, if necessary, a dose of purgative medicine may be given, 5 grains of calomel followed by castor-oil or a dessert-spoonful of some saline medicine such as granular effervescing citrate of magnesia.

It is to be remembered that sometimes, after a patient has begun to rally, a relapse occurs. Therefore he is to be watched carefully. As soon as the pulse, breathing, and colour are improved, stimulants should be given less frequently, but watchfulness exercised so that on the slightest appearance of renewed depression an additional quantity might be given.

The treatment of shock accompanied by restlessness is to be conducted on the same lines, for the restlessness and excitement are indicative of great weakness to be met by stimulating drinks and nourishment.

Insensibility or **Unconsciousness** may arise from many causes, from concussion of the brain (p. 104) as the result of a fall or a blow, from shock (p. 990), from an epileptic (p. 123) or apoplectic (p. 103) fit, from fainting (p. 243), from poisoning by alcohol (p.1024) or opium (p.1025). The symptoms of these conditions have been already described in the paragraphs already referred to and the appropriate treatment stated. Great and sudden loss of blood will also cause deep unconsciousness. The surroundings will often indicate clearly the nature of the case. It may be evident from the situation and position of the body that the person has fallen from a height; the presence of wounds will assist the formation of an opinion. If the unconsciousness is due to loss of blood from a wound, or a rup-

tured varicose vein, this will usually be evident. The features of apoplexy (see p. 103) are easily distinguished from shock or fainting.

In all cases lay the patient on his back, the head slightly supported; have him under cover; remove all tight clothing; arrest any bleeding; restore and maintain the heat of the body by friction and warm applications. In cases of shock, fainting, loss of blood, stimulants are necessary. But in apoplectic seizures, concussion of the brain, and epilepsy, efforts to restore consciousness and the use of stimulants are hurtful. Alcohol and opium poisoning are spoken of elsewhere.

THE TEMPORARY TREATMENT OF FRACTURES.

Fractures have been considered at length on p. 35 and the following pages, and the causes, varieties, symptoms, and treatment of them have been detailed at length. In this part, devoted to accidents and emergencies, however, it is thought advisable to make a brief summary of the means by which the fact that a bone has been broken may be determined quickly in the cricket, football, or hunting field, and to explain how, without any of the special appliances described in the pages referred to, such accidents may be temporarily treated, so that additional injury may not be inflicted before surgical aid arrives, or in course of conveying the person within reach of it.

Such information is of the utmost value to all engaged in out-door sports and to many others besides, and ought to be in the possession of everyone. Such an injury may be readily sustained, and often is so, by even a simple jump from a style, by a fall, by a kick, by a fall from a horse. In the most of these cases the injury is comparatively simple, the damage done is not extensive, and if the broken bone were, then and there, properly secured till it could be treated by a surgeon, comparatively rapid recovery would be made. But very often much more extensive damage is inflicted than that due to the original accident, because of the want of knowledge of how to handle the limb on the part of those who come to the aid of the injured man. Too often a patient, who has suffered a break of one of the bones of the lower leg, is encouraged to make repeated attempts at walking, supported on each side, or is roughly and unskilfully carried to some shelter, the injured limb being permitted to dangle and twist, to the grievous injury of the soft parts. A simple fracture is often thus converted into a compound one by the ends of the broken bone being thrust through the soft parts, or by its movement vessels are torn and nerves injured, and a simple injury converted into one of great extent and gravity, while inflammation is excited and much pain inflicted. All this a little knowledge would render impossible. No harm is done if a limb is supposed to be broken, the bone of which has really suffered no such injury, and if under the mistaken notion the temporary treatment for a broken bone be adopted, while great injury and suffering may be the result of mistaking a fracture for a dislocation or of failure to think of the possibility of fracture at all.

The General Signs of Fracture will be briefly stated. They are noted in detail on p. 36. The first is immediate disablement. If the leg be broken the person falls to the ground, and if he attempts to rise it is only to fall again. The broken arm falls by the side. When the collar-bone is broken the shoulder drops and cannot be raised by the person himself. Then the limb is more easily moved than its fellow; it bends at the break, unless in the case of the lower leg or forearm, when only one of the two bones is broken and the other acts as a splint. On pressing with the thumbs at the seat of injury the two ends of the bone yield and a grating feeling may be experienced. Usually deformity is produced by the muscles acting on one or other of the parts of the bone; thus, in the case of the thigh, the limb is shortened and turned out, and so on.

We shall notice the more common fractures separately and indicate how they are to be temporarily adjusted, the directions given being in every case fully illustrated in Plate XV.

Temporary Treatment of Fractured Collar-bone.—In this case the dropped shoulder, which the person cannot raise by action of the muscles, the ends of the broken bone projecting under the skin at the upper part of the chest, and their mobility and grating, indicate the nature of the accident. A firm pad is to be made, which can be improvised of pocket handkerchiefs, a soft cap, a waistcoat rolled up, or for that matter a bundle of hay rolled up in a handkerchief; and it is to be placed well up into the arm-pit to raise the shoulder. If the person applying the pad will grasp the upper arm, high up, with the left hand, and raise the shoulder, bracing it back at the same time, and then push up the pad, the replacement will be effected. The forearm is to be bent and folded over the chest, and kept in that position till a bandage is passed round the chest—a triangular bandage,

or a handkerchief or a neckerchief, or if nothing else is to be had a belt or a brace—to fix it there. Lastly the arm is to be supported in a large sling, the elbow being well held up. (See fig. in Plate XV.)

Temporary Treatment of Broken Upper Arm.—Here the position in which the person holds the arm is significant. He supports the elbow by the hand of the uninjured side, holding it close to his side. The mobility of the upper arm, the shortening produced, the irregular hollow felt on passing the hand down from the shoulder, whose roundness is maintained, all indicate at once what is wrong. The ragged ends may readily be felt even through a coat sleeve. It is not necessary to remove any clothing, in fact inadvisable, for every disturbance except by a skilled person is apt to be hurtful. Let the forearm be bent and held over the chest, let the person assisting put a narrow sling round the neck, supporting the wrist but *not the elbow* (see Plate XV). That done, let him look for something to act as a splint. A piece of paling may suit, or a pair of hunting whips (see Plate XV.), or a walking-stick broken in two. Something should be wrapped round the temporary splints to protect the arm from undue pressure. One piece is to be placed on the front and another on the outer side, and inside it will be well to place a pad, which a folded waistcoat will readily supply. Then let something to fix them with be looked for, handkerchiefs, neckties, braces. In the case of the hunting whips, the whip ends might do in the absence of everything else. Let all be got ready to save unnecessary handling of the arm. Then place the splints in position on the front and outer side of the arm and the pad on the inner side, *take care that the pad does not press too far up into the arm-pit to hinder the circulation*, and place the straps ready to be tightened. Then let one person firmly grasp the arm above the elbow and pull gently but steadily downwards. The displaced ends of bone will readily be brought opposite one another, and then the straps are firmly secured to keep them so. If only one person be present beside the injured man, it will be necessary for him to apply the splints and partially tighten the bandages before pulling on the limb, in order that when the arm is pulled down he may be able to complete the tightening with one hand, while he holds the arm in extension with the other. By having the sling on previously his task will be easier. If two persons are present to assist, one will keep the fragments together while the other adjusts the splints and bandages.

Temporary Treatment of Broken Forearm.—If only one of the two bones of the forearm (see Plate I.) be broken, temporary treatment is very simple. It is only necessary to place the arm in a broad sling, without disturbing any clothing or applying any splint, for the unbroken bone acts as a splint. That such a break has occurred is discovered by passing the thumbs one after the other along first one side of the forearm and then the other. When the break is reached, pain is complained of by the person, the bones are perceived to yield, and grating is felt by the person assisting. If both bones be broken, the forearm yields completely at the break and deformity is produced. Here again two pieces of paling, the two halves of a broken walking-stick, &c., are to be procured. If such a narrow piece of wood as a stick affords is all that is to be had, it is better to roll it up in a waistcoat or anything else which will give it some breadth and prevent it pressing unduly on one part of the forearm only. If the injured person has his coat on, it should not be removed; if he happens to be at the time coatless some soft padding *must* be interposed between the arm and the extemporized splints. Bend the forearm and carry it across the chest, thumb directed upwards. Apply the padded splints so that one lies along the front of the forearm, projecting out beyond the elbow behind, *not pressing into the elbow*, while the other lies along the outer side, and secure with one or two straps, which handkerchiefs, neck-ties, garters, &c., will provide. If both bones are broken it is necessary before applying the splints to grasp the hand, and, the elbow being fixed, gently to pull on it to reduce displacement and bring the broken ends opposite one another, in which position the forearm must be fixed. This is not necessary if only one bone is broken, since the sound bone prevents displacement as a rule. Then support the forearm in a sling, the broad sling will be best though the narrow one is represented in Plate XV.

Temporary Treatment of Broken Thigh-bone.—This accident is recognized by the fact that the person cannot use the limb, which is shortened and turned outwards, so that as the person lies on the ground the heel of the uninjured limb rests on the ground while the foot of the broken leg lies on its *outer side*. It is quite unnecessary to remove any clothing, to cut up the trousers, or disturb the clothing in any way. Let the foot of the injured leg be taken by one person, the heel resting in the palm of the left hand and the other hand over the back of the

boot, and let that person gently pull on the foot, turning it into its correct position, so that the heel is directed downwards and the toes upwards; let him bring it alongside its fellow, pulling on it so that the two limbs are of the same length. Meanwhile let another make a pad by rolling up a jacket lengthways, or other suitable material, and place it between the two thighs, extending pretty well up, and down beyond the knee at all events. Then let a splint be found. If only one person is present to assist the injured man, he may insert the pad between the thighs then draw on the foot, and tie both limbs together at the ankle by means of a handkerchief, thereafter going to find a splint. The splint must be long enough to reach nearly up to the arm-pit and down to project beyond the feet. Again a piece of wood torn from a paling might suit. In Plate XV., one figure shows how a rifle might be used, the stock resting up near the arm-pit and the barrel passing down the leg. Let it be noted that the barrel should not be allowed to rest on the ground but should pass *along the middle of the leg*. In the case of the rifle or anything so thin, a pad to surround it and so increase its breadth would be a great advantage. The extemporized splint being applied is to be fixed by several triangular bandages, handkerchiefs, or the like, which are to secure, not only the splint on the outside but also the pad on the inside. Finally a strap is to be passed round the body and the upper end of the splint, and another binds both legs together. Thus one leg acts as a splint on the inner side of the other.

After this has been done, as the person will be compelled to lie flat on the ground till means are provided for his removal, those assisting him should see that he is protected as far as possible from damp on the ground by coats, &c., gently passed under him, or he may at once be carried to drier ground if four persons be present, by the method described in the section dealing with stretchers. Three persons kneel down on the left knee on one side of him, one at the head and shoulders, another opposite the hips, a third at the lower legs, while the fourth kneels down on the other side, opposite the middle of the three. All four insinuate their arms under him and all acting together rise as one man, and slowly carry him off. In laying him down again they must be careful again all to act together.

Temporary Treatment of Broken Lower Leg.—The treatment of this accident is quite similar to that of broken forearm and is usually easy, since commonly only one of the two bones of the lower leg is broken, though, of course, both may suffer. In the case of only one being broken, though the person cannot walk or support himself on that leg, there is no displacement, the sound bone acting as a splint. But on passing the fingers along the outer and then the inner side of the leg, a place is reached where pain is complained of, the bones are found to yield and grating is felt. Again it is quite unnecessary to cut up the trousers or remove any part of the clothing. A splint is wanted for the outside of the limb, and, if it can be obtained, for the inside also. Plate XV. shows how two bayonets might be used, or the scabbard of a short sword. In the case of the bayonets it would be necessary to protect the leg from their sharp edges by enveloping them in some thick material which would act as a pad. Whenever possible the extemporized splint should be made to project beyond the foot and should be broad enough there to prevent the foot moving from side to side. Plate XV. shows a cricket bat applied for such a purpose. The splints being padded and applied, one outside and the other inside, they are to be secured by three fastenings at least. If only one splint is available place it outside and put a pad inside. It will be an additional protection to the injured limb, if the two legs be then bound together near the ankles and knees.

Temporary Treatment of Broken Ribs.—The danger of a broken rib or of broken ribs is that, in the carriage of the person, or in his own walking for help, the movement causes one of the broken ends to puncture the lung or do other similar damage. This is the more likely to happen the farther round towards the back the fracture happens to be. Short difficult breathing accompanied by pain, following a fall or blow or squeeze, should lead one to suspect this accident. The person usually carries himself also in a particular way, leaning over to the injured side, and keeping his arm close against it to restrain movement. This is the object of temporary treatment, and is quickly applied by passing a stout *broad* bandage round the chest and fixing it firmly. A shawl might be folded along its length to an appropriate amount, and wound firmly round the body for this purpose, being fixed by pins.

Temporary Treatment of Broken Lower Jaw may be applied by means of an ordinary handkerchief of sufficient length by tearing it into a four-tailed bandage (p. 959). It is torn down the middle from each end to within 3

inches of the centre. The centre is placed over the chin, the lower tails carried up the side of the head and tied on the top and the upper ones to the back of the head, being tied there. Refer to p. 959.

THE CARRIAGE OF INJURED PERSONS.

Of equal importance with the appropriate temporary treatment of injured persons, specially such as have had the misfortune to get a bone broken, is their skilful conveyance to shelter or assistance. Fractures can hardly be put up, however skilfully, so as to render it difficult to do serious injury in transporting the person from one place to another, and any simple means which will lessen the chances of further harm is worth noting. Two persons alone may carry an injured man for a considerable distance without any appliance at all, if he can assume a sitting posture, by forming a two, three, or four handed seat.

A Two-handed Seat is formed by the two carriers standing in line, making a quarter turn towards one another, and locking their hands together by the fingers, palms upwards, the right hand of the right-hand man locking with the left hand of the left-hand man, the other hand of each resting on the shoulder of the other (see fig. 3, Plate XIV.). The locked hands form the seat and support the patient under the thigh-bones a little above the knees, while the other arms support the patient's back. The patient may be able to assist by putting an arm round the shoulder of each bearer.

A Three-handed Seat is formed by the carrier on the right grasping his left forearm above the wrist with the right hand. He then grasps the left forearm of the left-hand bearer, whose left hand grasps the right wrist of his neighbour (fig. 4, Plate XIV.). The left-hand bearer's free right hand is laid on his neighbour's shoulder. The joined arms thus form a triangular seat, and the left-hand bearer's right arm supports the patient's back.

A Four-handed Seat is used when the patient is able to support himself in the sitting position by placing his arms round his bearers' shoulders. Each bearer grasps his own right forearm, near the wrist, with his left hand, and with his free hand grasps his neighbour's left forearm (fig. 5, Plate XIV.). This is called a "Queen's Chair."

Chairs.—A person who may be carried in a sitting posture may be transported in a chair, a high-backed chair if his head and shoulders need support, or an ordinary chair, if he can maintain his sitting posture unaided by a support to his back. A rocking-chair may be utilized for the purpose by passing two stout long sticks, fully longer than broomsticks, under the chair, one on each side, and tying them. The staves should slope downwards from back to front, passing close under the seat at the back and being tied at the junction of the seat and the uprights of the back, and passing *under* the lower round in front, and securing each at the junction of the round and the front upright of its own side. A bearer in front and one behind, standing between the trams thus formed, will easily carry the chair, as the old-fashioned sedan-chair used to be carried. A person with broken ribs should thus be carried in the sitting position, or by a two or three handed seat.

School Forms, Settees, Garden Seats, &c., may be utilized for those who must be transported lying at full length, as in cases of broken thigh-bone, as illustrated in fig. 2, Plate XIV. Such a seat could be carried by hand by four bearers, if a stout stave were passed under the seat at each end in a direction across its length, so that it projected at each side.

Rifle and Blanket Stretcher.—A stretcher may be improvised by means of two rifles and a blanket as shown in fig. 1, Plate XIV. The rug or blanket is fully unrolled. Under each of the two sides a rifle is placed, and the rug is firmly rolled in round the rifle, till the space between the two rifles is reduced to 20 inches. An improvised stretcher may be made of a blanket and rug and four stout poles; rake handles would be suitable. Two long poles are placed on the ground parallel to one another, 18 to 20 inches apart. Near their ends they are crossed by two of shorter length. The poles are firmly tied with whip-cord where they cross one another. The blanket, rug, or sheet is then fastened on, specially well down the sides and at the angles where the poles cross.

Stretchers and Stretcher Drill are considered in detail in a succeeding section.

Plate XIV. fig. 6 shows how by means of a bath towel an injured man, who is able to support himself in a sitting posture, may be carried up a stair with comparative ease.

When it is necessary for one man to carry another, he will do so most easily by placing himself on his patient's right side and lifting him so high that the upper part of the patient's body leans over his left shoulder, the bearer's

FIRST-AID IN ACCIDENTS.

I. This illustrates the application of splints for first-aid in a case of fracture of the lower right leg. An outer and inner splint have been applied and fixed by bandages, knotted on the outside. The legs have then been bandaged together, by one bandage passing over the ankles and another below the knees.

The plate also shows four men of a stretcher squad, kneeling on the left knee, lifting the patient, preparatory to placing the stretcher under him.

II. In this plate an injured man is shown with a triangular bandage applied over the head, the shoulder bandaged by a triangular bandage, and the wrist supported in a sling.

He is being carried by a two-handed seat.

Plate XVa.

I. First-aid in fracture of Lower Leg.

II. Injured Head and Shoulder, patient being carried by a two-handed seat.

left arm passing round his patient's back under his arms, and his right under his legs just above the knees. Captain E. M. Shaw, of the London Metropolitan Fire Brigade, has described another method. First turn the person face downwards, the helper standing in line with the patient and in front of his head. Let the helper then raise the person by taking hold close under his arm-pits, as high as he can, till the body rests on one of the knees. The bearer then stoops, places his arms round the patient's waist and lifts him to an upright position. Again stooping, the bearer passes one arm between the legs and round one of them, grasping with the other hand one of the patient's wrists. The person's body then falls over the helper's shoulder, and he rises with him in this position. The patient's arms are hanging over the helper's back, so that to grasp one of his wrists the arm has to be caught from behind and pulled forward under the bearer's arm. The patient is thus fixed securely on the bearer's shoulder, the hold on the leg prevents him falling backwards, and that on the wrist from slipping down.

Section IV.

THE EFFECTS OF HEAT AND COLD: BURNS AND SCALDS: SUNSTROKE AND HEAT-FEVER: LIGHTNING AND ELECTRIC STROKE: FROST-BITE AND CHILBLAINS.

First Aid in Accidents by Fire: The Extinction of Flames.
Burns and Scalds:
Burns of the First, Second, and Third Degree;
The Treatment of Burns and Scalds—Carron-oil;
Burns from Explosions of Gas, Gunpowder, Burning Clothing, &c.;
Scalds of Mouth, Throat, and Gullet;
Burns from Chemicals;
Burns of the Eyeball.
Sunstroke and Heat-fever.
Lightning Stroke:
The Effects of Strong Electric Currents.
The Effects of Cold:
Frost-bite and Chilblains.

ACCIDENTS BY FIRE: THE EXTINCTION OF FLAMES.

There is a very large amount of injury to person and property due to fire accidents, which, at the outset, were of a very insignificant and minor character. Of course, in a sense, all fires, however gigantic their ultimate proportions, are absolutely insignificant in their beginnings, just as the electric flash that fires a hundred-ton gun, or discharges a torpedo is in itself insignificant. The great fire which laid Chicago in ruins is a case in point; and the most recent illustration is furnished by the fire at a charity bazaar in Paris in this year (1897), which was due to a trifling accident with an ether lamp, and which would have done no injury to anyone but for the fact that it was surrounded by light gauzy inflammable stuff. Though the electric flash and such a lamp accident are in themselves insignificant, the surroundings, in which they occur, render their results uncontrollable from the beginning. It is not, therefore, this wide application that is meant when it is said that a very large amount of injury is done by fire accidents of very little moment at the outset. The reference is to a large class of fire accidents quite controllable at the beginning, if only there be someone in the neighbourhood who knows what to do, and is prompt in the doing of it, but which, because of the absence of knowledge and promptitude, become in a few seconds uncontrollable and disastrous. Take, for instance, the case of a pot of inflammable material, like sugar, boiling over, or like the mixture of rosin and turpentine melting over a fire to produce the preparation known to druggists as Venice turpentine. Take the case of an overturned paraffin lamp, or a window curtain set on fire by a gas bracket, or a person's clothing set on fire. In the large majority of these cases the fire can be extinguished speedily and with little damage, if instantly and properly dealt with. But too often the person presiding over the melting pot, or whose carelessness has set the curtain on fire, or overturned the lamp, loses presence of mind and rushes away to get help, and the

delay, however brief, is fatal. Still more, if a woman's clothes have caught fire, is she likely in her distraction to rush about fanning the flames, when a moment's self-possession would save her. How to deal with such minor accidents should be part of the teaching of the young, just as the girl of twelve years is not now deemed too young to be taught, as part of her swimming lessons, the rescue of those in danger of drowning.

Fire cannot live without air. The process of burning is the process of rapid union of something with the oxygen of the air. If the air be cut off the fire must go out, will go out of itself. Anything which hinders the supply of air will limit the fire, and just because the union must be rapid for the production of flame the hindrance need not be complete for the extinction of the flame to be accomplished.

In the next place flame ascends. It extends more rapidly in the vertical than in the horizontal direction. A hanging curtain, therefore, will be speedily enveloped in flames above the part first set on fire, while the flame will only creep slowly along the same curtain lying on the ground. Similarly if a person's clothing has been set on fire, the flames will speedily reach the upper part of the body so long as the person remains erect, but will spread with comparative slowness if the person gets flat on the ground. Moreover, if a person whose clothes have been set on fire rushes distractedly about, she is taking the most effective means of feeding the flames with fresh supplies of air and destroying her chances of escape.

These are the two principles on which the kind of accidents now being referred to are to be dealt with. How are the principles carried into practical effect?

Let us deal, in the first place, with such accidents as an overturned lighted lamp, a pot of inflammable stuff boiling over, a burning curtain. The pot should be pulled off the fire, set down on the floor as far from the fire as possible, and, if it continue in flames, something should be thrown over it, a sack, a quilt, a coat, a rug, a table-cloth, anything close enough in texture to hinder the access of air to the burning mass, and not itself readily inflammable. The flames will be immediately extinguished. Water would be useless for such a purpose, at least in the quantity readily available. The writer has seen a large pot of flaming turpentine thus instantly extinguished without injury to anyone, and in the very midst of an apartment so full of the most inflammable material that a few minutes' delay would have involved a conflagration.

An overturned lamp should be dealt with in the same way. In this case the lamp will have rolled, and the paraffin will have run, and a flowing river of fire will have to be controlled. One is apt to try to extinguish the whole with the same rug, or shawl, or other cloth, by dragging it from one part to another of the stream. This must not be done, else the part just extinguished is almost sure to be relighted as the cloth is dragged from one place to the other. Shawl after rug, table-cloth after shawl, coat after table-cloth must be thrown on the flames, and one article not moved till the whole is extinguished.

In the case of a curtain set on fire, it must be dragged as swiftly as possible from its hangings, thrown down, and something then thrown over it, as in the other cases. But the person who is engaged with such an accident, especially if the person be a woman, cannot be too careful lest the fire spread from the curtains to her own person. In the case of a curtain the necessity for haste is not so desperate, and a moment or two of deliberate thought, as to how best to proceed to avoid the graver accident, will be well-spent time.

When a woman's clothing has caught fire, the same principles must be applied. She ought immediately to throw herself on the ground, and roll over and over, while she shouts for help. She will often be able, thus, herself to extinguish the flames without help. Even if this happy result be not so easily attained, she delays the flames reaching her face and head, which are, in such cases, the parts often most severely burned, and this delay may be her ultimate salvation. Unfortunately so many persons, in such a desperate situation, so completely lose presence of mind, that the knowledge of what ought to be done is no guarantee of its being done. The first thing, therefore, to be done by any one who rushes to help is to shout to the woman to lie down, and, if need be, to throw her down. The person who rushes to help also runs into danger. This danger is little in the case of a man, but very great in the case of a woman. Either should, on the way, seize rug or shawl, with which, in the act of being thrown down, the person may be enveloped, and by which, when she is down, the flames may be extinguished. This is not so necessary, however, for the man, whose own clothes will less readily take fire; so that, as he runs, he may simply divest himself of his coat,

which he throws over the person in flames, and probably with his hands he will be able to smother out the flames from any part left uncovered.

A woman who goes to help, however, must provide herself with something by means of which she may not only envelop the person, but save her own clothes from catching fire. A blanket, shawl, table-cover, sofa-blanket, would be suitable. This she should hold in front of her, **causing it to trail on the ground**, for if it do not touch the ground, the flames may curl in under its lower edge and set her own clothes on fire before she has been able to render any assistance, and a new victim would be added to the flames.

If the person on fire has already thrown herself on the floor, she should be approached **from the head**, and the blanket allowed to fall on her from the head towards the feet, so that the flames will be extinguished from the head downwards. The rescuer, kneeling down at the sufferer's head, can then, if necessary, push the blanket down over the body towards the feet and press it close to the body and limbs, and so extinguish the flames with little risk to herself.

If the sufferer be rushing distractedly about, it is all the more necessary that the rescuer should be provided with something sufficiently large to interpose a complete barrier between the person on fire and himself, so that the rescuer may, by extending the arms, as in the act of embracing, completely envelop the person on fire, without lifting the lower edge of the enveloping material from the floor. The patient should then be thrown down, and the flames completely extinguished by pressing the covering close in to her body.

It must not be forgotten that it is the limitation of the access of air which extinguishes the flames. Whatever is used, therefore, to throw over the patient must be sufficiently thick and close in texture to achieve this result. Thin, wide-meshed stuff will not be effectual, and may only add fuel to the fire. If, therefore, the material be suited for the purpose, pressing it close to the side of the patient's body, and well down over the feet, is mainly for the purpose of preventing a current of air passing up over the person, and so fanning the flame. The close application of the wrapper to the *parts of the clothing on fire* is not, therefore, necessary, if the wrapper be large enough, and may be actually hurtful, by pressing the burnt clothing, still hot and smouldering, on to the patient's body, and so producing burns of the surface, which might, but for that pressure, have been avoided, and which may have very serious after-effects.

As soon as the flames have been extinguished, the burnt clothing should be removed from contact with the patient, being cut off carefully, and not torn off roughly, for reasons stated fully on p. 999.

THE EFFECTS OF HEAT: BURNS AND SCALDS.

There is no practical difference either in results or in treatment between a burn and a scald; the former is the result of dry heat, the contact with a heated substance, hot metal, &c., the latter is the result of contact with moist heat, hot water, steam, or hot fluid of other kinds.

There are various degrees of injury inflicted by heat, and thus a burn of the first degree is spoken of, or a burn of the second degree or of the third. The difference between these is a difference in the depth to which the injury extends, and this naturally depends on the heat of the substance which has produced the injury and on the length of time during which it was applied.

A burn of the first degree is one in which only the immediate surface of the skin is injured. The part is red, somewhat swollen, and very painful, with a stinging tingling pain, and tender to the touch. That is to say, there is a slight degree of inflammation of the skin and increased flow of blood to the injured part, but there is no blister, and no destruction of tissue, though the surface skin, the epidermis, afterwards peels off.

A burn of the second degree is one in which, owing to the severity of the injury, part of the surface layer of the skin is raised in a short time by the formation of a blister. If the fluid be allowed to escape from it, the raised skin soon dries and protects the irritated surface beneath, on which within six or eight days new epidermis is produced, and the dead dried layer separates, leaving the fresh surface sound and without scar. The pain of this degree of burn is considerably greater than the former. If the dead horny layer of the skin be removed before the new layer has formed a raw surface is left, from which matter may be given off. But soon a scab forms, under the protection of which the new layer is produced. This process may last two or three weeks.

A burn of the third degree extends through the whole depth of the skin and perhaps even into the tissues beneath. The destruction pro-

duced causes sloughing or separation of the destroyed piece of skin, and then a granulating wound (see p. 968) is left, healing with the discharge of matter like other granulating wounds. No new true skin can be produced to fill up the gap, but a scar or cicatrix is left. When such burns are extensive they cause serious deformity by their contraction and consequent pulling upon neighbouring parts. The new tissue formed to fill up the gap has never the full vitality of surrounding parts, and is always evident by its glazed appearance, its greater or less depression below the surface, its tendency to blueness with exposure to cold, and so on. The deformity produced by such extensive burns is sometimes of a very serious character. The contraction of an extensive scar of the neck and side of the head will pull the head down towards one side; that near a joint will sometimes cause permanent bending and diminished mobility of the limb. When the wound has completely healed, rubbing of the part and appropriate manipulation will often effect considerable stretching of the new tissue and diminish the deformity, but the tendency to contraction always remains. It has been thought that the scars of burns have a much greater and more confirmed tendency to contraction than those of other wounds. But it must be remembered that few other kinds of injury produce destruction over such a large and continuous surface, and probably the great degree of contraction is due rather to the large surface over which the scar extends than to any special contractile property.

The length of time which elapses before recovery from a burn of such a degree is naturally very variable. It is always much longer than that taken by slighter degrees, because here there are parts actually destroyed to a greater or less depth. Time is taken by the natural process of repair for the removal of these dead pieces of tissue, and then there is the still longer period required for the filling up of the breach. Moreover, in cases of burns the separation of dead pieces of tissue and the filling up of the gaps produced go on more slowly than in the case of injuries from other causes, which may involve equally extensive destruction. The actual time, of course, depends upon the depth of the destruction and the superficial extent, but the suffering and exhaustion caused by the tedious process are very great.

All these different degrees of burn, it will be observed, depend simply on the depth of tissue involved. In the first case only the immediate surface of the skin is affected, and that to a slight extent; in the second the action of the heat has penetrated partially through the epidermis or horny layer of the skin, in the third it has passed right through the skin and may have reached muscles, tendons, nerves, &c., below. The immediate result and the immediate danger of burns is the shock or state of depressed vital action (p. 990) which they produce. No other kind of injury produces so profound a lowering of the vital functions. This shock is often a very grave condition, threatening speedy death, and, even when it does not end fatally, is much prolonged. On whatever part of the body the burn is situated the shock is great, but it is most marked when it is the chest or abdomen that is affected; and it is more pronounced in women and children than in men. The seriousness of the shock is in proportion to the extent of *surface* involved, not in proportion to the *depth* of the injury. A merely superficial burn of the abdomen or chest of large surface will more readily prove fatal from the depression than a limited burn on an arm or leg, even though it extends almost down to the bone. If a burn involve more than half the surface of the body a fatal result is practically certain. The explanation of this is not clear. Commonly the death is due to the shock to the nervous system. But even when the shock is passed through, death occurs from other causes. In cases examined after death from shock, the internal organs have been found congested, and also the brain, and in cases in which the shock has passed off (in something like forty-eight hours) numerous symptoms point to these organs as being profoundly disturbed. For, following the shock, comes a period of reaction and inflammatory fever, in which, in addition to the bounding pulse and increased temperature, there are dryness and redness of tongue, thirst, loss of appetite, vomiting, and often diarrhœa. These symptoms indicate mischief in the digestive organs, and that inflammation of these organs occurs is shown by blood sometimes occurring in the motions, and by blood and albumin in the urine. Ulceration of the bowel may occur and inflammation of the lungs. The symptoms frequently resemble those of blood poisoning, which has led to one opinion that many of these complications are due to the functions of the skin being interfered with by the large extent of surface involved, and by the consequent retention in the blood of materials which the skin ought to have cast out of the body. Even when the symptoms of inflammatory fever have passed,

which may not be for a couple of weeks, there is still grave cause for apprehension, specially in the case of women, children, old people and persons of indifferent bodily vigour, lest the drain upon the system involved in the prolonged suppuration and the exhaustion of continued suffering may completely undermine the strength and end in death by exhaustion.

The Treatment of Burns and Scalds.—The chief attention in the first place is to be paid to the condition of the patient, and until some steps have been taken in view of the shock which has been sustained the treatment of the injury may be postponed. This immediate treatment has been already sufficiently described under Shock (p. 991). The patient is to be laid flat in bed or on a couch with the head low, great care being exercised in the carriage and moving of him not to inflict further damage on the injured parts. Efforts are to be made to restore animation by the application of warmth to the surface of the body, and stimulants of hot tea or coffee, ammonia in water, whisky in water, or ether, if the shock be profound, are to be administered in one or other of the methods advised on p. 992. While this is being attended to by one person, others may be engaged doing what is needful for the injured parts. As already said, there is to be no hurry permitted in this. In the excitement of the moment persons are apt to proceed to tear off the clothes, thoughtless of the injury they may thereby inflict, and entirely unprepared, when the clothing is removed, with any suitable coverings for the burnt parts. Now two rules must be rigidly adhered to: (1) the clothes must not be *pulled off* the injured parts; they are to be carefully *cut off* by scissors or a sharp knife, and if any portion of clothing is adherent it is to be left rather than forcibly removed, the free parts being cut off; (2) the burnt surface must not be exposed before materials for quickly covering it are ready to hand. So completely ready must the dressings be that the exposure to the air of the burnt surface is of the smallest possible duration, otherwise the shock is likely to be aggravated. Some gauge of the superficial extent of the injury may be obtained from the appearances of the clothing, and suitable dressings may therefore be ready.

It is necessary, at the risk of repetition, to emphasize these points: *attend first to the effort to restore the patient from shock, then arrange suitable dressings, and do not remove the clothing till the dressings are ready for immediate application.*

Now the question arises, What are the suitable dressings? They are such as will protect the burnt parts from the action of the air, and will at the same time soothe them. Dredging the burn thickly with flour or whiting is sometimes resorted to in an emergency, but is not so suitable as the use of oil, because of the crusts it will form with the fluid from the burn, nor is it so likely to be at hand. It is better to cover the part with strips of lint soaked in oil, or sheets of cotton-wool well saturated with oil. In an emergency any oil will do, sweet-oil, almond or olive or salad or castor oil. But the oil most commonly employed is carron-oil, originally made of equal parts of linseed-oil and lime-water, but olive-oil is to be preferred for it. It is a most soothing application, and affords a most grateful relief to the patient. The smell of the preparation is, however, not pleasant, and it does not hinder the parts becoming foul-smelling. Some, therefore, prefer carbolic acid oil, 1 ounce of the carbolic acid to 40 ounces of olive-oil. If the pain be very intense the oil may be made of the strength of 1 of acid to 20 of oil; and this strength sometimes diminishes the sensitiveness of the surface in a very striking way. The carron-oil is, however, perfectly suitable to begin with, and antiseptic preparations may be used later if needful. Sheets of cotton-wool, of abundant size, soaked in this preparation, are then to be got ready and laid, on a plate or tray, by the side of the patient, before the clothing is removed. If blisters have already risen, great care is to be exerted not to tear them open in removing the clothing. If part of the clothing be adherent, cut round it, pour oil upon it, and then cover the whole surface, piece of clothing included, with the oily sheets of wool. If the burnt surface is very extensive, one part is not to remain exposed till other parts have been freed from clothing, but the dressings should be applied bit by bit, just as part after part is uncovered. It will greatly facilitate the process of healing if, in cases of blistering, the raised horny layer of the skin is allowed to remain as a protection to the parts below. All that is needful is to snip the blister at its lowest corner, and at any other part necessary to permit the complete escape of all the fluid, which is to be gently pressed out, and then the dressings applied. The oily covering having been adjusted, a large sheet of cotton-wool, the Gamgee tissue or carbolized gauze or any variety of antiseptic wool (now readily obtainable from druggists), should cover over all, and be fixed by means of a light bandage.

All this time someone must be paying attention to the patient, maintaining the warmth of other parts, administering stimulants, and so on. But the stimulants must be given with great discrimination in view of the subsequent inflammatory fever. The stage of shock will last from two or three hours up to twenty-four or forty-eight, according to the extent of the burn and the sensitiveness of the patient. The person must be guided by the pulse, the breathing, and the appearance of the skin, and on seeing indications of revival refrain from further use of stimulants, at the same time watching against a relapse.

The time of re-dressing must be determined not only by the state of the injury but also by the state of the patient. It is certain to be painful, perhaps exquisitely so, and to subject a patient to such pain who had hardly recovered from the shock of the injury would be very improper. It is indeed often deemed proper by surgeons to carry out the first one or two re-dressings with the patient under chloroform. The first dressing may quite safely be left for two or three days if the discharge from the burn is little or none, and there is no foul smell. But the appearance of any foul smell should suffice to determine its being immediately done. It must be carried out with equal care to the first. The new dressings are all to be ready before the first are removed; the first are never to be torn off. If adherent, they must be soaked by streams of water containing an antiseptic such as carbolic or boracic or salicylic acid, and the old dressing should be removed bit by bit, the new being applied in the same way. Any pieces of clothing left on the first dressing may now be easily removed by the stream of water. Where the destruction passes deeply into the tissues, so that sloughing is caused, frequent re-dressing and cleansing with antiseptic solutions becomes a necessity to prevent the putrefying appearance and odour of the separating pieces. Besides the carbolic lotion, Condy's fluid may be used for this purpose, or the perchloride of mercury lotion. Indeed, when the burn has reached the stage when the destroyed portions are separating, and still more when these dead pieces are separated and the wound is granulating, must the treatment adopted be similar to that already described for lacerated wounds, or a wound healing by granulation (refer to p. 968). When the scar tissue is forming and beginning to contract, great care and much patience and ingenuity require to be exercised to diminish deformity. In severe burns it is impossible to prevent all deformity, but it may be much lessened by the application of splints to hinder forced bending of joints, and by kneading, rubbing, and other manipulations when the wound has closed over.

In order to shorten the process of healing over of such extensive wounds, and to diminish deformity, the process of **skin grafting** has been introduced. This consists in snipping off from some healthy part of the body small pieces of skin, not throughout the whole depth but only from the surface layers of the skin. These fragments are planted on the surface of a healthily healing part of the surface of the wound, and hasten its covering in, lessening also the amount of shrinkage of the scar. A much more satisfactory method, however, consists in the transplanting of considerable pieces of skin. The size of the piece desired is marked out on a piece of paper, and this is laid on some part of the healthy body, arm or leg, and the extent of surface needed to be transferred thus accurately determined. This mapped-out piece of skin is now carefully dissected off with a clean sharp knife, the whole thickness of skin being removed. When the piece has been cut out, it is carefully trimmed, all fatty tissue from the under surface of the skin flap is carefully removed by scissors, and it is then placed in position on the desired portion of the wound, which has been cleaned and dried previously. The author has seen a piece of skin of the size of a half-crown piece thus removed from the arm and transplanted to the upper eyelid to fill up a gap, left after the cutting out of a piece of scar tissue by whose contraction the eyelid was being turned inside out, everted. The transplanted flap was retained in position simply by the pressure of clean lint and a lightly applied bandage. It took root, so to speak, became completely incorporated with the surrounding parts, and indeed almost indistinguishable from the surrounding skin, the form of the eyelid being very satisfactorily restored. When, first, flaps of skin were transplanted it was thought to be necessary to retain a connection by a sort of bridge of tissue with their old site, by which some blood supply was maintained till they had formed a connection with the new locality. This implied the removal of the transplanted flap from the immediate vicinity of the wound, or if the flap were removed from the arm to some part of the face it meant the binding up of the arm into close proximity to the face, and in a painfully constrained fashion, for many days. The newer method, which has shown that the skin may be completely sepa-

rated from one place and yet retain vitality enough to become an integral part of another part, is due to Dr. Wolfe, of Glasgow, who has on several occasions employed it for the restoration of eyelids. It is especially serviceable in the case of scars of the face from burns or other injuries, which may seriously spoil the person's appearance, and in the case specially of a woman be a cause of much annoyance. In these instances the scar of the old injury is simply dissected out, a piece of skin the requisite size is removed from some part of the body, usually concealed by the clothing, and transplanted to the face. The new wound, thus produced, is allowed to heal up in the usual simple way. Professor Esmarch of Kiel has published (1889) the details of several operations he has performed by Wolfe's method on the face with great gain to the personal appearance of the persons.

Now we have described in detail the treatment of extensive and deep burns, which end in scarring. The treatment of burns, in which no great thickness of skin is affected, in which there may be blistering but no scar, is comparatively simple, except for the shock, which, as already said, may be even more grave than that attending deep burns of less area. The oily applications need less frequent renewal than in cases where there are sloughing and discharge, and from first to last nothing but oily applications may be necessary. The carron-oil may be used to the end without fœtor or discharge if the skin of the blisters have not been removed. To prevent smelling without giving up the use of the carron-oil some carbolic acid may be added to it (1 ounce of the acid to 40 of the carron-oil).

Many other applications are advised, specially at first when the pain is great. Among others, a saturated solution of common washing soda is advised as affording great relief, and a thin ointment of iodoform and vaseline. A mixture of chalk or whiting and vinegar is also praised for the speed with which it relieves pain.

For slight and merely surface burns immersion in cold water for a few seconds at a time will be found very soothing. Cold water applications laid on and left for any time are useless; they become so speedily warm. But if a stream of cold water be allowed to flow over the part for half to one minute at short intervals, or an iced cloth be applied, great relief follows for a little. When the stinging pain has thus been removed, enveloping the part in a thin layer of antiseptic wool or gauze is afterwards sufficient. Of course if the burn covered a large surface, however superficial it might be, one would be slow to use cold water in this way unless all fear of prostration had passed away.

These, then, are the means of treatment usually recommended to be employed. The author, however, has experience of another method, and though it is many years since it was applied on his own person he has still grateful recollections of its ease and its pain-relieving character. It consists in treating the burn by the application of carron-oil, but without any dressings whatever. The carron-oil is applied by means of a feather or brush on the burnt surface, into contact with which neither lint nor cotton nor any material whatever is allowed to come. It is only applicable to burns of the first and second degree, and not when there is separation of parts. The person lies in bed with the part quite uncovered and yet under the bed-clothes, this being accomplished by some contrivance which keeps the clothes off the skin. This is easily arranged. A wire guard can be procured to be placed over the burnt member, arm or leg, or to span the chest or abdomen or neck; and it bears the weight of the clothes. The person is kept perfectly warm, although the bed-clothes need not touch him at all except about the head. Such a guard can be easily improvised by using an ordinary wooden box or drawer. When the drawer is wanted to cover a leg or arm, one end is knocked out, and the box then placed over the limb. In the case of the leg it should be deep enough to permit the foot to rest on the heel. In the case of chest or abdomen, both ends are knocked out, and the box then placed over the body. With such an arrangement it

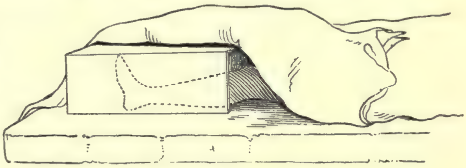


Fig. 374.—Protector for Burnt Leg.

is exceedingly easy to turn the bed-clothes partially down in order to reapply the carron-oil at frequent intervals. The surface is thus kept cool and comfortable and the pain and distress of each re-dressing completely avoided. Fig. 374 shows a common kitchen drawer prepared and in use for such a purpose.

Burns from Explosions of Gas, gunpowder, from contact with burning clothes, and so on, are to be treated on precisely the same lines. Every now and again one reads of severe injuries sustained by a person's clothing catching

fire, and the person being extensively burned on face, hands, arms, neck, &c. Many of these accidents issue fatally, not from the actual injury, but from the combined shock of terror and the large extent of surface involved. Very many such accidents might be reduced to small proportions, if the person did not lose all presence of mind and go rushing about from place to place, and if spectators did not also lose presence of mind in witnessing it. A person whose clothing catches fire may quickly smother out the flames in many instances, at the risk of burning the hands, by firmly grasping the clothing and covering over the flaming parts with other portions unattacked. Or the person may throw herself or himself on the floor, and by rolling over on the part in flames extinguish it. Or the person may envelop herself in a plaid, overcoat, rug, shawl, &c., and then roll on the floor. Anyone near may help to extinguish the flame by throwing the person down and smothering out the flame with his hands or his own garments, or throwing a rug over the person, tightly enveloping him or her.

Scalds of the Mouth, Throat, and Gullet.—These accidents are more common in children than in adults, and are in children often due to the trick of drinking from a teapot or kettle spout. When the scald is limited to the fore part of the mouth the danger is not great, but great pain is caused, and the tongue may swell so much as to be forced out of the mouth. Cold water immediately used and freely and frequently repeated is advised, and, later, to the cold water a few drops of carbolic acid may be added, the mixture being well stirred before use. Sips of cold milk and iced milk are to be frequently given, and small pieces of ice to suck. When the throat and top of the gullet have been reached, the case is much more serious, for the top of the box of the windpipe is necessarily affected, and the swelling which very speedily arises may threaten to cause death by suffocation. A surgeon must be immediately sent for, since in the event of such a result being threatened, it may arise in a comparatively short time, and opening of the windpipe is the only sure means of permitting breathing to go on till the swelling subsides, though scarification may reduce the swelling sufficiently to prevent suffocation. In the meantime sips of iced water and iced milk are to be given, and small pieces of ice to suck. Of course shock will require to be treated as already described on p. 991. Even when the risk of suffocation has been averted, serious danger is not all past. If there has been any destruction of tissue in the gullet a scar results, and as healing goes on the resulting contraction may so diminish the diameter of the tube as to produce stricture, and render swallowing difficult if not ultimately impossible.

Burns from Chemicals, strong acids, such as vitriol, nitric acid or aqua fortis, spirit of salt, strong carbolic acid, quicklime, caustic soda or potash, are produced with great rapidity. The action of any of these substances penetrates deeply and quickly, producing destruction to a considerable depth, and always causing sloughing and scarring. So quickly are they produced that there is almost no time to obtain anything fully to antagonize their effects. Such acids will quickly burn through clothing. Cold water will probably be at hand in most instances, and is to be used freely. If the substance has passed over any extent of surface no mere washing will do. If abundance of water is at hand, the person should not hesitate to plunge into it and freely move about in it; or the limb affected should be thrust in and moved rapidly to and fro, or the head should be dipped in. No time is to be wasted removing clothing, the instant dilution of the substance with water is desired. In the case of acids any alkaline substance at hand, soda, lime, &c., should be added to the water to neutralize it; and in the case of lime, caustic potash or soda, acid—vinegar, for example—should be added. After this has been done, and as much of the corrosive substance removed as possible, the part may be treated as for an ordinary burn or wound.

Such corrosive substances are sometimes swallowed by mistake. Large draughts of water should be taken; in the case of acids, lime and water, soda and water; and in the case of solutions of caustic soda or lime or potash, vinegar and water. In the case of vitriol it must be remembered that the addition of water to it develops great heat, and great quantities of water would require to be taken rapidly. Lime could be torn from a wall and given with water. The immediate attendance of a medical man is necessary, for should the shock and other immediate effects be recovered from, prolonged and exhausting illness from ulceration and sloughing of parts is certain to follow, if any has reached the gullet and stomach. Indeed such cases are usually speedily fatal.

Burns of the Eyeball and Lids with dry heat, hot metal, &c., are to be treated with the atropinized castor-oil mentioned on p. 369. If lime has reached the eye a wash of vinegar and water, *never water alone,* is to be used, and if acid,

a solution of soda or lime-water, or water alone, except in the case of oil of vitriol.

Sunstroke (*Heat-stroke, Heat-fever, Coup de Soleil, Insolatio*). Sunstroke appears really to include several diseases. There is first of all the form due to exposure to the direct rays of a hot sun, especially when they have been beating upon the head and neck. The liability to the attack is increased if the air is much heated, and if the person has been engaged in any laborious or exhausting occupation. Thus soldiers on the march, carrying heavy accoutrements and cumbered with clothing, are apt to be smitten in large numbers. This is common, wherever the direct heat of the sun is very great, and not only in India and tropical countries. It is also known in England. The symptoms very often arise suddenly, the person falling down insensible, and exhibiting all the symptoms of extreme nerve shock. The pulse is feeble and rapid, the breathing gasping, the skin is pale and cold, and death may occur quickly from failure of the heart and the breathing. These effects seem to be due to congestion of the brain and other nerve-centres; and if recovery occurs, while it may be complete, it is often imperfect, permanent changes in nervous structures leading to impaired intellect and generally enfeebled health.

Sometimes there are symptoms previous to the attack warning of its threatened onset. These are a feeling of great weariness and prostration, dizziness, sickness, restlessness and sleeplessness, dryness and heat of the skin, and incontinence of urine or a tendency to frequent passing of water.

But another form of the disease may occur, altogether without exposure to the direct rays of the sun. This may be produced by working in air heated by the sun's rays or by artificial means. Persons working in a confined space, with impure atmosphere, especially if depressed and exhausted by work, fatigue, or dissipation, or in a poor condition of general health, may be attacked. It is frequent in the case of soldiers in hot confined barracks, workmen, stokers or engineers on board ship, specially in hot climates. In summer such cases occur in many of the large swift steamers, where the men are kept working in the very hot and close atmosphere of the engine-room or stoke-room. This is specially apt to happen in certain conditions of the atmosphere, when the air is still and laden with moisture. In countries, such as Bengal, where the atmosphere is not only warm but damp, the liability to such an attack is greater. For a hot atmosphere which is also dry is tolerated far more readily than one which is moist. In the dry hot atmosphere, evaporation from the skin is encouraged, and the temperature of the body kept down, but this is prevented in the case of air already laden with moisture. This variety is called **heat-fever**, or **ardent fever**, and is common in India, attacking not only foreigners but natives also, though the latter can tolerate a much higher degree of heat than the former. To this variety also persons with enfeebled general health more readily succumb than those of sound and vigorous constitution, who live healthy temperate lives free from any vitiating influences. The attack may occur in the shade, at night, just as much as in the daytime or in the sunlight, provided the person is under the depressing influence of a close confined atmosphere, vitiated by overcrowding.

In cases of this variety the fever induced by the heat is very high. There is great weakening of the heart, the breathing is quick and gasping, the skin burning, thirst is great, and there is marked restlessness, and frequent calls to pass water. The skin of the face, head, and neck is congested with blood and livid; and the pupils dilate widely before death. If death is about to occur, its approach is heralded by delirium and convulsions, stupor, involuntary evacuation of the bowels, and suppression of urine. Recovery may occur, but not complete, impairment of intellect and feeble health being the consequences of inflammatory changes in the brain and injury to other organs. Recovery may seem to set in to be followed by relapse. When death occurs it is usually within twenty-four or forty-eight hours.

Symptoms may occur for some hours or even days before the illness develops, significant of what is about to follow. A general feeling of ill-health, restlessness, and sleeplessness, disturbances of bowels and bladder, sometimes thirst, loss of appetite, a feeling of sickness, giddiness, headache, a feeling of anxiety, and a sense of impending evil, and quick short breathing are among these premonitory symptoms.

A milder form of illness due to exposure to a hot atmosphere in the circumstances already mentioned is called **heat exhaustion.** Its symptoms are those of nervous collapse, the skin is cold, pale, and clammy, pulse quick and weak, there is complete prostration of muscular strength, and while complete recovery may be effected by appropriate treatment, death may take place suddenly from failure of the heart.

Treatment of Sunstroke and Heat-fever. In the last condition mentioned, that of heat exhaustion, the patient should be removed to a cool room or place where the atmosphere is fresh. All heavy and tight clothing should be removed or loosened, cold should be applied to the head and back of the neck either in the form of an ice cap or in the form of a cold douche. The application of cold, however, must not be pushed too far, lest it lead to further depression of vital powers. For the rest, stimulating treatment may be needful; smelling salts, not too strong, should be held to the nostrils for an instant or two at intervals; weak liquor ammonia, 15 drops at a time, well diluted with water, may be given by the mouth, or weak spirit and water, and nourishing food must also at frequent intervals be administered if possible. At the same time stimulants must be administered with great caution, and discontinued as soon as signs of returning animation appear. If rashly and inconsiderately used they are certain to aggravate the condition of reaction which follows the collapse. It may be necessary to maintain the breathing by artificial respiration.

In the case of heat-fever, cold is also to be applied to the head and spine, as an ice bag or cold douche. Here again care must be taken not to produce depression. But the ice application may be continued at frequent intervals until the heat of skin abates and the fever is reduced. This should be ascertained, if possible, by a thermometer whose bulb is passed up into the bowel (see p. 10). If consciousness does not return, blisters may be applied to the nape of the neck, and, after shaving, to the back of the head. The bowels should be freely relieved, though not powerfully purged. The use of food and stimulants may be adopted on the lines already indicated. At one time bleeding was advocated to relieve the turgid and livid appearance of the head and face and the laboured breathing, but is not now advocated, it being recognized that any measures which further reduce the patient's strength are only likely to make a fatal termination certain.

When a person drops suddenly to the ground with sunstroke, he is to be immediately removed to the shade and a stream of cold water is to be poured from a height upon his head, neck, and body, as he lies stretched out on the ground. All tight and heavy clothing should be removed; and if the cold water be immediately and freely applied a return to consciousness will very often be brought about. Injections to relieve the bowels, and mustard applications over nape of neck and heart, may be required.

Any person who has suffered from any form of sunstroke should be exceedingly careful to avoid any subsequent exposure. Those who have recovered either wholly or partially from the severer forms should seek immediate removal to a cooler climate. Even in a temperate climate much exposure to a warm sun should be avoided; regularity in habits of body should be rigidly practised; and the person should abstain completely from all forms of alcoholic stimulants.

The mortality from sunstroke is estimated at between 40 and 50 per cent, and of those who do recover, many retain some permanent indication of the attack in some form of nervous weakness or disturbance of greater or less severity.

Lightning Stroke.—Death may be caused instantaneously by lightning and no trace of its action be visible, the sudden shock to the nervous system having immediately arrested the vital functions. In other cases evidence of the stroke is found in greater or less amount. Wounds may be produced of a character to mark off one in the position where the current entered and another as its point of exit. The clothing may be rent and torn from the body with great violence; boots may be riven in pieces, metallic bodies in the pockets, a knife, keys, a watch or chain, may have attracted the current and be fused, broken to pieces, or magnetized. The body itself may suffer in a great variety of ways, internal organs may be disorganized, and the skin may be scorched. Scorchings of the skin very often assume a curious branching tree-like arrangement according to the way in which the electric fluid has swept over it. It was at one time a popular belief that such markings were photographs of some tree in the neighbourhood of the place where the person was struck. A person may be so struck that a limb is separated from the body, though this is not common. A person who is not directly struck, but is in the immediate neighbourhood of the place struck, may yet be seriously injured. The effects resemble those of concussion of the brain (see p. 104), weak pulse, slow feeble breathing, dilated pupils; and the person may remain unconscious for a considerable time, from a few minutes to hours or even days. The effects produced may be but slight, sudden giddiness confusion, faintness, recovered from in a few minutes. The more serious cases may be attended by paralysis of the limbs or affection of

the senses, blindness, wholly or partially, loss or perversion of smell, deafness or noises in the ears, &c., loss of memory and some affection of brain may remain. Paralysis arising from lightning stroke may be removed sooner or later. Trees are very often struck by lightning, and it is regarded as unwise to take shelter under them during a storm, but the beech-tree is said never to be assailed, and it is in many places believed that it is impossible for one sheltered under it to be struck.

The treatment of lightning stroke consists at first in the treatment appropriate to concussion of the brain or nervous shock from other causes. Efforts are to be made to restore animation by friction of the limbs, the application of warmth to the body, and, if it appear needful, the judicious use of stimulants. The cold douche suddenly applied and quickly suspended is said to be of great value for rousing the circulation and breathing. Breathing may require to be maintained artificially.

Electric Shock differs in no essential particulars from lightning stroke, when it is received in sufficiently intense currents to be injurious. Any differences that occur are only differences in degree. Death by electricity is unhappily becoming now a common accident, in many cases being attended by features of special horror. Reports of electric lighting employees being killed by electric shock from overhead wires while working on house roofs, and of the body, entangled by the wires, being slowly scorched, are becoming painfully numerous. Persons cannot be sufficiently on their guard against touching in any way any electric conductors, and specially against touching or stepping on any overhead wire that may have fallen and be lying on the footway. Though it might be only a telegraph or telephone wire it is wisest to err on the safe side.

THE EFFECTS OF COLD.

Long-continued cold acting upon the whole body produces general depression, which is manifested by a feeling of coldness and chilliness, followed by uneasy tingling of the body. The skin is pale and corrugated. The body gradually feels benumbed, and with the languid circulation a sense of languor and drowsiness creeps on, to which the person is almost irresistibly inclined to yield himself. His muscular power becomes very feeble; he is oppressed with a feeling of weight and an intense desire to sleep; his ideas are confused and his mental faculties blunted, and if not almost forcibly prevented he yields to the languor that overpowers him and lies down. The cold continuing to act upon him, the heart's action becomes feeble, quick, and irregular; breathing is laboured and slow; the pupils of the eye dilate; a heavy stupor overtakes him, ending in death. In other and less extreme cases the effects upon the nervous system are manifested, not in stupor, but in delirium, wandering or raving in character, and sleeplessness.

The **treatment** of a person thus overpowered must be carried out with great care. It is universally admitted that any sudden change from the state of cold to one of heat is to be entirely avoided as likely to prove fatal. The restoration of warmth must be very gradual. The person should be divested of his clothing and laid, rolled in cold blankets, in a *quite cold room.* Rubbing the body with ice or snow is commonly recommended, and this may be alternated with light friction with cold flannel or fur. This must be persevered in for hours if necessary. When the patient shows signs of returning animation the room may be very slightly warmed. With the return of consciousness pains may be complained of in the limbs, especially if they have been warmed too rapidly, and it is deemed advisable to envelop the limb in cloths soaked with cold water. As gradual relaxation of the stiffened parts occurs, some slightly stimulating liniment may be employed with which to continue the rubbing—soap-liniment, tincture of arnica, or camphorated spirit. Mildly stimulating drinks are then given, warm tea, coffee, beef-tea, or soup, but no alcoholic stimulants till later. In fact the restoration of the bodily heat must be brought about very gradually throughout, and the frictions of the whole body must be steadily maintained but never in too vigorous a fashion. *The efforts at restoration must be persisted in for many hours.* The following case, occurring in America, may be given in illustration: "An Esquimau had his leg frozen above the knee-joint, stiff, colourless, and to all appearances lifeless. He was placed in a snow-house, at a temperature of 20° *below* zero (Fahrenheit). The parts were bathed in ice-cold water for about two hours, and then enveloped in furs for three or four hours. Then frictions were used, first with the feathery side of a bird-skin, then with snow, alternately wrapping the limb in furs and rubbing it for nearly twenty-four hours. It was next carefully wrapped up, and the temperature of the snow-house raised by lamps above zero. On the third day the patient was taken to his

house (in the Esquimaux houses there is often a temperature of 70° or 80° Fahrenheit), and in seventy hours was walking about, with only a slight frost-bite on one of his toes." "This case," adds the narrator, Dr. Hayes, "shows how much may be accomplished with care and perseverance, even under the most adverse circumstances."

Some interesting experiments made by Pflueger, a German physiologist, throw some light on the cause of the difference between slow and rapid warming after an intense degree of cold. He experimented with frogs, and after freezing a frog till it was as hard and stiff as a board, he thawed it out very slowly, with the result of restoration of animation, the frog being able to jump about though in a languid way. The author has himself seen a frog hopping about, which, hours before, had been frozen hard in a Bell-Coleman freezing-machine. The idea of Pflueger's explanation is, that if rapid thawing occurs the waters of the tissues separate out, and the tissues are left in a moist dead state, while if the thawing be accomplished slowly enough the water is taken up and organically incorporated with the reviving tissues.

A person who is subject to intense and long-continued cold must be encouraged to move actively about. The desire to sit down and yield to the languor must be combated in a most determined manner. Stimulants, at least alcoholic stimulants, are not to be administered. They are harmful rather than useful, because, as explained on p. 673, they rather accelerate the loss of heat from the body by dilating the blood-vessels of the skin. A sharp, clear, dry cold is much less hurtful than a damp cold, for the moisture of the latter soaks the clothing and causes them to become better conductors of heat, so that heat is lost from the body with much greater rapidity. Naturally, persons who have been subject to prolonged fatigue and insufficient nourishment will yield to the influences of cold much more rapidly than those who are fresh and well nourished. While alcoholic stimulants are objected to, warm stimulating articles of food, that is to say substances which nourish as well as stimulate, warm soup, beef-tea, milk, &c., may be freely taken by those exposed to cold.

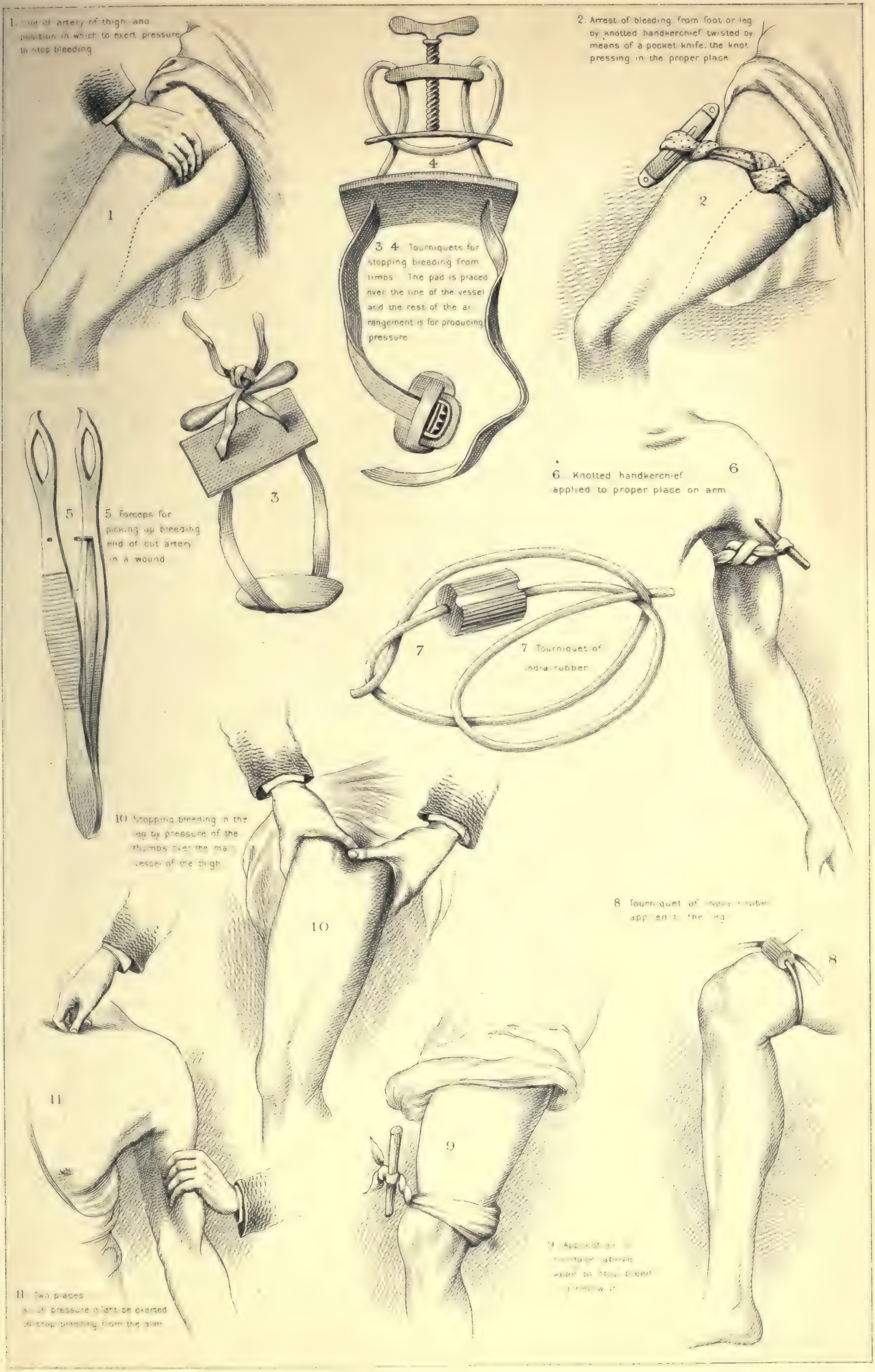
As a protection against external cold nothing is equal to a fair quantity of fat in and underneath the skin. The thin man will, other things being equal, succumb long before the fat man. Then in cold weather and cold climates the heat-producing articles of food, specially fat, should be freely consumed (see p. 619), and non-conductors of heat used for clothing (see p. 723).

Frost-bite is the condition of coldness, numbness, and loss of power attacking a part of the body, exactly the condition already described as affecting the whole body, but limited to a part of it. The parts usually affected are the extremities, the toes and fingers, feet and hands, nose and ears, because these are the parts at greatest distance from the centre of circulation. There are various degrees of frost-bite, as there are various degrees of burn. The frost-bite may only be sufficient to produce coldness and numbness of the affected parts, the skin of which becomes white and wrinkled; and, when heat is restored, marked reaction occurs with redness, heat, tingling, itching, and swelling of the parts. The more rapidly the change from cold to heat occurs, the more marked and violent is this inflammatory reaction, but it soon subsides, and restoration to the normal state occurs. If the cold be more intense and longer applied a second degree of frost-bite occurs. Complete loss of sensation takes place; the parts become discoloured, blisters form filled with fluid, which may be clear but is often bloody. If the cold have been so intense as to freeze the part through and through, it will be hard, stiff, and brittle, and in this state the part might actually be separated from the body by breaking. Usually, however, the parts are purple, have lost feeling, and, if pricked, only a drop of dark blood escapes. One must not conclude that restoration of such parts is hopeless; for by appropriate and careful treatment recovery from even this degree of frost-bite is possible. In a greater degree of frost-bite the death of the part is complete, it passes into a contracted shrivelled condition, and drops off from the body, a red line of demarcation marking the separation between the dead and the living. That is to say, the part separates by gangrene.

The **treatment of frost-bite** is identical for that already described for the whole body benumbed by cold. Under no circumstances must a sudden change from the intense cold to heat be indulged in. A person who, after long exposure to cold, at last reaches shelter with a hand or a foot or fingers or toes in this benumbed condition, is apt to seek the immediate aid of external heat, of a warm fire, of hot water, and so on. This is attended by grave danger not only to the benumbed parts but also to the whole body. Numerous illustrations of the danger of such procedure are derived from the

METHODS OF ARRESTING BLEEDING.

Plate XVI.



experience of armies in the field. Soldiers, exposed for long periods to the cold, at last seek the warmth of the camp fire and stretch out their benumbed hands and feet to the blaze, only to determine gangrene of the extremities by the sudden transition. It has even been noticed that such results followed, in the case of troops exposed to a cold night-watch, if a sudden thaw set in, the mere natural transition from a low to a much higher temperature being badly borne by the frost-bitten parts.

The treatment, then, that is invariably advised is gentle friction, at first with snow or ice-cold water in a cold room, and a very gradual elevation of temperature as a gradual return of animation becomes evident. As the limb begins to approach the normal degree of heat, it may be wrapped in flannels or furs or cotton-wool. If the part does not recover, the separation about to be effected by gangrene is revealed by the appearance of a red zone between the living and the dead parts. In the case of fingers and toes, warm linseed-meal poultices are commonly employed to aid the separation of the slough. To keep down smell antiseptic dressings are employed as in the case of wounds, and when the dead part has been removed the stump is to be treated in the ordinary way as a granulating wound (p. 972). During this period the strength of the patient requires maintenance by nourishing food, perhaps also by stimulants and tonics. In the case of a foot or hand or a large portion of a limb, as soon as gangrene became evident, a surgeon would perform an amputation to save the patient the prolonged suffering and exhaustion of the natural method of separation, and to get rid of the risks of blood poisoning which might otherwise arise.

Parts which have once been frost-bitten and have recovered are liable, on a repetition of the exposure, to a repetition of the attack. Care should therefore be taken, by the use of extra protection by woollen material or fur, to guard against such a return.

The milder degrees of frost-bite require caution in the application of heat, but are usually rapidly recovered from. Rubbing with snow, and subsequent wrapping of the parts in flannel or fur with gradual elevation of temperature, will commonly suffice; and, when the parts are restored to a normal degree of heat, light friction with some of the stimulating liniments or ointments recommended for chilblains will be useful.

Chilblains are degrees of the effects of cold milder than frost-bite. A part of the skin is in a state of inflammation due to cold. There is some amount of swelling, redness, heat and tingling, and the itching pain is increased by heat. The patch of skin, in cases of greater severity, may be purple or livid, and blebs or blisters may form upon it. The blisters may break and leave a suppurating or ulcerating surface.

The treatment of chilblains is conducted on similar lines to that of frost-bite. Warmth is not to be restored, after the exposure, by hot water or by holding the part before the fire. Rubbing with snow or iced water is again recommended, or simple gentle friction with the hands. Later a liniment of opium or soap and opium, and subsequently a more stimulating liniment, such as camphor liniment or turpentine liniment or tincture of iodine, are recommended. If the skin is not broken ointment of iodine is said to be one of the very best of applications. After this the part should be enveloped in flannel or carded cotton.

While the fingers and toes are usually attacked, the nose and ears frequently suffer; and if in one winter season the ears of a person have become affected, the probability of a recurrence the following season should be remembered and precautions taken.

Young persons are specially prone to be attacked by chilblains, and specially such as are not of vigorous constitution.

The prevention of chilblains is better than their cure; and if it is remembered that it is not the mere exposure to cold that determines their occurrence, but the sudden change from severe cold to heat, one of the chief means of prevention is indicated. Persons with chilled fingers or toes *must keep from the fire* till the heat of the parts has returned naturally. Then, of course, efficient protection should be provided for hands, feet, ears, &c., by the use of suitable clothing, woollen stockings, snow-shoes, woollen gloves, &c. Active exercise during exposure to the cold, and rubbing, should be engaged in to prevent the numbing of parts.

SECTION V.—SUFFOCATION OR ASPHYXIA. RESTORATION FROM THREATENED DROWNING, CHOKING, HANGING, STRANGULATION.

Suffocation or Asphyxia:
Its Causes, Stages, and Treatment;
Suffocation from Foul Gases and its Treatment.
Drowning:
Methods of Artificial Respiration—Sylvester's, Howard's, Marshall Hall's.
Choking.
Hanging and Strangulation.

SUFFOCATION.

Suffocation is the condition which arises when an animal is deprived, by any means, of a due supply of air fitted for maintaining the proper condition of the blood. In Part I., Section IX., p. 249, the purpose of breathing has been described at length. Its purpose is two-fold. The gas called oxygen is needed in the body to effect the chemical changes by which the nourishment taken is converted into power of doing work or energy, and into heat, and by which the integrity of the body is maintained. By the work of the body a gas, called carbonic acid gas, is produced, which if allowed to remain in the body becomes speedily injurious, acting as a poison. The fuller explanation of these facts will be obtained in the section already named, and in the early paragraphs on food, p. 531. Now the lungs are the organs by which at once new supplies of oxygen are introduced to the blood and carbonic acid gas removed from it. We do not breathe pure oxygen, but the ordinary atmospheric air we breathe contains oxygen, diluted with a neutral gas, nitrogen. Now any circumstance which will prevent the blood obtaining its proper supplies of oxygen will produce symptoms, more or less marked according to the degree to which the oxygen is wanting. These are symptoms of suffocation, using the word in its scientific sense, or, to use the scientific term, **asphyxia** (Greek *a*, not, and *sphuxis*, the pulse). The literal meaning of this word is, therefore, pulselessness, though it is used to mean the condition described. The early symptoms, and the symptoms which arise when the deficiency of oxygen is not great, would not be popularly recognized as symptoms of suffocation, but simply as symptoms of difficult and laboured breathing (p. 284), or **dyspnœa** (Greek *dus*, with difficulty, and *pneo*, I breathe), for in the popular mind the term suffocation is used to imply the condition in which the person is, from want of breath, in immediate danger of death. Nevertheless, these symptoms are merely the early symptoms of a slight degree of that condition in which oxygen is not gaining entrance to the blood, which, if it becomes aggravated, is readily recognized as a state of suffocation.

It is quite clear, then, that suffocation or asphyxia may arise from a great many causes, and not merely from the commonly recognized cause of blocking the windpipe by pressure from without or by something falling into it from the mouth. Suppose a person's lungs are in thoroughly good order, but he is placed in a small confined space into which no fresh air can enter. By and by he will so have exhausted the supply of oxygen in the air of that apartment that he can get no fresh supplies into his blood. He will die from want of fresh air, from want of oxygen, from suffocation, just as much as if he had been seized by the throat and strangled. Of course there will be an additional element present, namely, that he has not only removed from the air all the oxygen he can, but he has polluted it with carbonic acid gas and other exhalations from his lungs, so that it will not be a pure case of suffocation, though it is that chiefly. Again, let us suppose that there is abundance of fresh air about a person, but that both lungs are blocked up with products of inflammation, as in inflammation of the lung, and that the air cannot penetrate to the recesses of the lung to reach the blood. Again he will die of suffocation, not from want of air or of oxygen in it, but because he cannot make use of it, the inflammation being the cause of his inability. Or let us suppose he has pleurisy of both sides, and that large quantities of fluid have been poured out round the lungs, causing them to be squeezed up into a corner of the chest, emptied of air, and prevented expanding, asphyxia again arises. Still again let us suppose that the atmosphere about him is pure

enough, and that his lungs are in a healthy state, but that there is a growth in his windpipe which gradually encroaches on its fairway till the passage for air is seriously blocked, clearly suffocation will arise. Take the case of membranous croup, diphtheria of the larynx or box of the windpipe in a child. The membrane which grows in the larynx rapidly narrows the passage for the air, and the child gasps and fights for the air that is around it in abundance, but which cannot pass the narrowed part of the tube sufficiently quickly for its purpose, and finally, if the membrane continues, the child dies of suffocation, worn out too by its struggles for breath. Once more, suppose a mass of food has "slipped down the wrong way" and gained entrance to the windpipe, which it blocks, suffocation again immediately arises, the person is deprived, at a stroke, of oxygen by the block in the pipe. Lastly, suppose the mouth and nostrils are stopped, or the windpipe closed by the hand of a garroter, or by the person's head being buried in sand or earth, or immersed in water, as in drowning, or the windpipe compressed, as in hanging or strangling by a rope, clearly the result in all cases is the same, no new supplies of oxygen gain entrance to the blood, and in all the death is by suffocation or asphyxia. If a person or animal were to be lowered into a pit or jar containing nitrogen gas only, the same condition would arise, death from want of oxygen, death from suffocation.

It is quite true that in most of these cases not only is there want of sufficient oxygen, but there is also hindrance to the output of the impure carbonic acid gas, and the retention of this gas in the body is undoubtedly a contributing cause to the death. But this added element of poisoning by accumulation of carbonic acid gas does not produce the characteristic symptoms of suffocation or asphyxia, the laboured breathing, the fight for breath. It has been proved that an atmosphere containing abundant supplies of oxygen, but also a poisonous amount of carbonic acid gas, will still produce death, but no longer attended by the symptoms of suffocation, but with the symptoms of narcotic poisoning. Headache, languor, stupor, unconscious and quiet death are now the result, not the struggle and convulsions of suffocation. To repeat, the symptoms to be described as those of suffocation are due to want of oxygen, from whatever cause that want may arise.

Symptoms.—The symptoms are best seen in all their intensity when the want of oxygen is sudden and extreme, as in drowning, choking, strangulation, and they occur in three stages. There is first the stage of dyspnœa or laboured breathing. It is a state of agitation and struggle. The movements of breathing are rapid, deep, and powerful. The ordinary muscles which produce the movements of the chest and abdomen are not only thrown into a state of intense activity, but the muscles of extraordinary respiration (p. 254) as well. The muscles between the head and chest and between the arms and chest, &c., are active, raising and pulling down the chest in the effort to get more air into the lungs. The movements of breathing are deep, prolonged, and hurried, passing into convulsive gasps for breath. This stage lasts for a minute or a minute and a half, and latterly spasmodic movements of the limbs occur. Meantime the veins of the face and surface of the body become swollen with dark-coloured blood, and the countenance is livid. In the second stage, the muscles which expel air from the lungs contract spasmodically, and this passes into a state in which nearly every muscle of the body acts convulsively, the bowels and bladder being emptied involuntarily, and general convulsions setting in. It lasts about a minute and passes into a state of exhaustion, in which the person lies still, the pupils being widely dilated; there is complete insensibility; the muscles are completely relaxed. Every now and then, however, there are a few convulsive gasps, which become weaker and feebler. Finally, a general convulsion occurs, in which the body is fully stretched out, the mouth is widely opened, and the nostrils dilated, the head is thrown back and the back straightened, and in one final effort to draw in breath the effort is over. The heart continues to beat for a few seconds longer, and at length stops in complete relaxation, when death has occurred. The whole period that elapses between the moment of complete deprivation of oxygen and death is 3 to 5 minutes. It varies in different animals; and young animals seem to be able to hold out longer than full-grown animals. At any moment in the period named, until the instant before the heart has ceased to beat, when the person is perfectly still and death seems already to have occurred, restoration is possible, if only oxygen can be introduced into the blood. The heart may still be feebly beating, even when no pulse can be felt.

The appearance of the body fully indicates the cause of death. The veins of the skin and of head and neck are gorged with dark blood;

and the face and head are swollen and turgid, and darkly purple or almost black.

All the movements that have been described are directly due to impulses to muscles from the nerve-centres, which are violently stimulated by the non-oxygenated state of the blood. They are completely beyond the control of the person, are not voluntarily made, and can occur from first to last even in a state of profound unconsciousness. The struggles thus made by a person are not, therefore, necessarily attended by pain, however painful and distressing they are to witness.

Treatment.—The perfectly clear indication for treatment is to render the admission of air to the lungs easy, if that be possible. In a case of inflammation of the lungs or of pleurisy, such as has been described, that could only be done by clearing the lungs or removing the pleuritic fluid. If the want of air be caused by blocking of the windpipe by something that has dropped from the mouth, it may be possible to remove it in the manner to be described under the head of choking. If the obstacle cannot so be removed, and if it be lodged high up, the admission of air may be rendered easy by making an opening into the windpipe from the neck, by the operation known as tracheotomy. If the person has succumbed from being in an atmosphere wanting in oxygen, removal to the outside air is the immediate step to be taken, and the loosening of the clothing about the neck and waist. If the person has been removed into pure air before the heart has ceased to beat, but when already the last stage of suffocation has been reached, and he lies quiet, making no effort to breathe, the movements of breathing may be stimulated by sudden dashing of cold water on the chest, or by flicking the chest with a wet towel. That failing, immediate effort must be made to produce artificial breathing by Sylvester's or Howard's method, described under Drowning, the preliminary step of removing water from the chest being, of course, unnecessary. In the case of children, especially, mouth-to-mouth insufflation may be practised, though Howard's method is best.

In the case of persons overcome by foul air in wells, pits, or in the recesses of quarries after blasting by gunpowder, they are to be quickly removed into fresh air, the clothing about the neck is to be rapidly unloosed, and artificial respiration practised.

Drowning means death by the air being prevented entering the lungs owing to the mouth and nostrils being immersed in a liquid, the liquid being commonly water. Death may, therefore, occur by drowning in a small quantity of water. Thus a child may fall head downwards into a tub and be drowned, though the tub is not half full of water, sufficient to cover the mouth and nostrils being all that is necessary, and a man overcome by a fit or by drunkenness may fall on a road with his head in a ditch or pool of water, and thus meet death. Death is thus due to suffocation, to the stoppage of breathing, and to the entrance of water into the lungs. When death has been caused by drowning, the skin presents the appearance called goose-skin (*cutis anserīna*), the face and surface of the body generally are usually pale, a frothy liquid is found in the lungs and air-passages, and about the lips and nostrils; water may be found in the stomach; and clenched fingers, holding substances grasped at, may serve to show that a struggle has taken place in the water, and that the body was alive at the time of immersion. Complete insensibility arises, it is probable, in from one to two minutes after submersion, recovery, however, being still possible, and death occurs in from two to five minutes. So long as the heart continues to beat, recovery is possible; after it has ceased it is impossible. Newly-born children and young puppies stand submersion longer than the more fully grown.

For the restoration of the apparently drowned several methods are suggested. Those of Dr. Sylvester, recommended by the English Humane Society, and Dr. Benjamin Howard, of New York, are the simplest, but that of Dr. Marshall Hall will also be described.

Whichever method is adopted, the following steps must first and immediately be taken: Pull the body up on to dry ground. Send immediately for medical assistance, warm blankets, dry clothing, brandy and hot water, if anyone is at hand to send. No delay must be permitted, however, in treating the person, so that if only one person is on the spot he must begin to treat the person *instantly*, without seeking assistance. Remove all clothing from the neck and chest. Fold the articles of dress removed so as to make a firm pillow, which is to be placed under the shoulders, so that the upper part of the body is slightly raised and the head slightly thrown back. Cleanse the mouth and nostrils, open the mouth and pull forward the tongue. If natural efforts to breathe are made, try to stimulate them by brisk rubbing of the sides of the chest and of the face. If no effort to breathe is made,

proceed to produce the entrance and outflow of air from the lungs by Sylvester's or Howard's method.

Sylvester's Method (Plate XVII.).—Stand or kneel behind the person's head, grasp each arm at the elbow, draw both arms simultaneously upwards till they are extended in line with the body, as a man places them when he stretches himself. Let this movement occupy about 2 seconds. This enlarges the chest and causes the entrance of air to the lungs. Without a pause carry the arms down to the sides, making them overlap the chest a little, and firmly press them on the chest. This movement should occupy other 2 seconds. It expels air from the lungs. Repeat the movements, and maintain them steadily and patiently at the rate of 15 times a minute, until breathing has been fully restored, or until medical aid arrives, or until death is certain. An hour is not too long a time to persist, and so long as there seems the least effort to breathe the efforts must be persevered in.

Howard's Method (Plate XVIII.).—Place the body on its face, with the roll of clothing under the stomach, the head being supported on the hand as shown in figure 1. Pull the body over the roll of clothing to expel water from the chest. Then turn the body on the back, the shoulders being supported as shown in fig. 2. Kneel over the body. Place both hands on the lower part of the chest, so that the thumbs hook in under the lowest ribs and the fingers are spread out on the chest. Steadily press forwards, raising the ribs, your own body being thus thrown leaning forward. This enlarges the cavity of the chest and causes air to enter. When the ribs have been raised to the utmost extent, with a slight effort push yourself back to the more erect position, allowing the ribs to recoil to their former position. This expels the air. Repeat the process 15 times a minute. One person will find it more easy to maintain this method for a prolonged period than Sylvester's, especially if the patient be big and heavy.

Meanwhile, if other persons are present they should be occupied rubbing the body and limbs (*always upwards*) with hands or warm flannel, applying hot flannels, bottles, &c., to the limbs, feet, arm-pits, &c. As soon as the person is sufficiently restored to be able to swallow, give small quantities of hot brandy and water, hot wine and water, hot coffee, &c., and use every effort to restore and maintain warmth.

Marshall Hall's Method.—After clearing the mouth and throat let the operator kneel on one side of the patient, who is placed on his back with the arm opposite the operator close down against the side, a folded coat or other article of dress being under the back. From this position let the operator turn the body up, away from him, on to the side and slightly farther so that the chest looks to the ground, and in this position let the operator press firmly on the side and back. This compresses the chest on the under arm, and expels the air. Let the pressure be removed and roll the patient slowly on to his back again. The chest expands slightly and the air enters. These movements are to be repeated steadily and regularly, about fifteen times a minute, once every four seconds. If another person be present let him attend to the movements of the head to keep it in line with the body as it is turned. The movements of the chest are not nearly so pronounced by this method as in Sylvester's or Howard's, but one man can perform them for a long time. This advantage is also possessed by Howard's method, which in addition causes much greater movement, and is, therefore, to be preferred.

Choking is caused by something slipping down from the mouth and blocking, more or less completely, the upper part of the air-passage. A portion of food may do this, or a coin, or other article which has been held in the mouth. Besides the sudden obstacle to breathing, there is commonly violent spasmodic cough due to irritation of the air-passages by the presence of the foreign substance, which may ultimately cause expulsion of the substance. Sometimes a mass of food will stick in the upper part of the gullet, causing violent effort to swallow or expel it, without at the same time seriously impeding the passage of air. But the feeling of its presence causes great agitation to the person, especially a child or young person, from the fear of suffocation. One must not mistake this state of terror for a state of threatened suffocation. In such cases one can easily perceive that there is no blueness of the face, no swollen state of the veins of the skin, and that the breath can be drawn in and expelled with comparative ease and fulness. The patient must be calmed, assured that there is no danger, and steps may then be quietly taken either to push the mass down into the gullet or to hook it out with the finger. The author remembers vividly a young man who had been eating a sandwich, a bite of which had stuck not at the back of the throat at all, but in the gullet, a short distance down. Owing to its

position it pressed forward on to the box of the windpipe in front, and produced the sensation of being in the upper part of the windpipe. The youth was in such a state of excitement and alarm as to make it difficult to assist him. His face, however, but for his terrified appearance, was natural and his breathing free. He was ordered to keep still, and to notice with what ease he continued breathing; and he thus became aware that no serious danger existed. He realized that he was quite safe from risk of suffocation, became quite quiet, and without further trouble a stomach-tube was passed down the gullet and the offending mass pushed safely into the stomach. But if the face becomes quickly swollen and livid, it is clear that suffocation is near, and immediate steps must be taken to avert it. Let the mouth be widely opened and kept from closing by something placed between the teeth, a thick cork, a piece of wood. This is necessary, to prevent the operator's finger being bitten. Then let the operator pass his forefinger through the mouth to the back of the throat. The finger should be passed in away to the side, the cheek being stretched as much as possible. This enables the finger to reach well down the throat. The finger is then swept round the throat in search of the obstruction, which it removes by being insinuated behind and beneath it. If this failed to relieve the person, a surgeon would open the windpipe by the operation of tracheotomy (p. 270), an operation which, in cases of simple obstruction, would relieve even at the very last moment. In the case of children the obstruction may sometimes be dislodged by holding the child up by the heels and smartly slapping the back between the shoulders with the flat of the hand.

In many cases where the breathing is much obstructed swallowing is still quite easy, and the expulsion of the obstacle may be effected by the action of vomiting. This is induced by a tea-spoonful of mustard in a tumbler of tepid water, or by copious draughts of lukewarm water, or by tea-spoonful doses of ipecacuanha wine.

Should ordinary measures fail, should a surgeon not be obtainable in time, is the person to be allowed to die because no skilled assistance is at hand? Surely not! In such an emergency let some person, sufficiently cool and collected, take a pair of sharp fine-pointed scissors, perfectly clean. The scissors must not be too thin in the blades. Lace scissors are too fine. Let him grasp them firmly, *closed*, in his right hand, extending the right forefinger along the *closed* blades to within ⅝ths of an inch of their points, and keeping it firmly pressed there to act as a stop. Let the patient be stretched out flat on his back, head thrown back, and let the operator lay his left forefinger on the front of the neck, just under the chin, and carry it down the front of the neck in a straight line till he feels the upper border of the larynx —Adam's apple. Let him carry his finger down the middle line of this prominence, pressing his finger point firmly on it, and a little way down his nail will slip into a little oval space between the lower edge of this upper part of the box of the windpipe and the succeeding gristly ring, the space marked o in Fig. 134, p. 262. At this point, only the skin and fatty tissue beneath it and a thin membrane covering over the space are interposed between the fairway of the windpipe and the outside. Keeping the left forefinger firmly pressing on this place to mark its exact site, an act attended with a little difficulty, for the box of the windpipe will be violently forced up and down with the convulsive efforts to breathe, the operator steadily pushes the scissor points through skin and membrane till they penetrate into the windpipe; the right forefinger acting as a stop ensures that they are not passed too far. The instant they have penetrated, a hissing noise, the noise of issuing air, will proclaim the fact, along with some frothy and bloody fluid. But the person must not be alarmed. He must, then, slowly separate the blades of the scissors, so as to enlarge the wound and keep it open, doing so until the air enters and issues freely. He must keep the scissors steadily in that position, being on guard lest they slip out owing to a convulsive cough or heave of the patient, or lest they be accidentally thrust farther in; and in this position he must keep them till a surgeon arrives. If struggle has ceased before the scissors have opened into the windpipe, and no effort of breathing be made by the patient, someone else must practise artificial respiration while the operator keeps the wound open. With no one to help him, the operator might yet keep the scissors in position with one hand and, by pressing heavily on the chest with the other and then removing the pressure, produce respiration to some extent.

If a coin has slipped into the windpipe it will commonly not completely block the passage, so that the necessity of extreme haste is not so great. But it produces violent spasms of coughing whenever it comes up near the box of the windpipe. Place the person flat on a

RESTORATION OF THE APPARENTLY DROWNED OR SUFFOCATED.

SILVESTER'S METHOD

Plate XVII

The movement by which air is made to enter the lungs.

The movement by which air is expelled from the lungs. The double movement should be carried on regularly at the rate of 15 times per minute and should be persisted in for an hour where the slightest hope of restoration exists.

couch which is easily lifted. Let someone hold him there so that he will not slip off, and let another suddenly lift the foot end high up so that the head is quickly brought to a low level. The coin may roll down the windpipe and out by the mouth. If not it will tickle the larynx and produce the storm of coughing. Bring the couch down to the horizontal, and, in a little time, repeat the manœuvre. If after patient effort this fails, an operation for extraction of the coin by opening the windpipe will be necessary.

Hanging, when there is no marked drop, produces death by suffocation. In the case of hanging as a capital punishment the noose is so arranged, and the length of drop so proportioned to the weight of the individual, that the sudden jerk, produced when the bolt of the platform on which the condemned man stands is drawn, causes dislocation between the first and second vertebræ of the neck and consequent destruction of the nerve-centres presiding over the action of the heart and lungs, so that death is instantaneous and with little or no struggle. But when a person hangs himself, death is by strangulation, the pressure of the rope compressing the windpipe. If any indications exist to suggest that a person found hanged is not quite dead, he should be immediately cut down and the noose unloosed or cut. The fingers and thumb grasping the windpipe where the pressure has been may re-establish the fairway of the tube if the pressure has obliterated it. Then artificial respiration should be performed by Howard's or Sylvester's method, friction should be applied or hot sponges over the heart, and if the patient revives some warm stimulant given.

Strangulation by whatever means is to be treated as directed for Hanging.

SECTION VI.—WHAT TO DO IN CASES OF POISONING.

Classification of Poisons:
Corrosive and Irritant, Narcotic, and Narcotico-irritant Poisons.
Symptoms of Poisoning:
Symptoms of Corrosive and Irritant Poisoning;
Symptoms of Narcotic Poisoning;
Symptoms of Narcotico-irritant Poisoning.
General Treatment of Poisoning:
Emetics and Antidotes.
Corrosive and Irritant Poisons:
Acid Poisons—Hydrochloric, Nitric, Sulphuric, Carbolic, Acetic, and Tartaric Acids;
Poisoning by Caustic Alkalies—Soda, Potash, Saltpetre, and Ammonia;
Metallic Poisons—Antimony, Arsenic, Lead, Mercury, Tin, Zinc;
Poisoning by Iodine and by Phosphorus and Lucifer Matches.
Poisoning by Alcohol.
Narcotic and other Nerve Poisons:
Opium and Morphia Poisoning;
Chloral Hydrate and Chlorodyne;
Hydrocyanic or Prussic Acid;
Aconite Poisoning;
Atropine and Belladonna Poisoning;
Calabar Bean (Physostigmine), Cannabis Indica (Indian Hemp), and Stramonium (Thorn-apple);
Nux-vomica and Strychnine Poisoning; Poisoning by Paraffin-oil.
Poisoning by Vegetable and Animal Irritants:
Aloes, Castor-oil Seeds, Croton-oil, Colocynth;
Elder Leaves and Flowers, Gamboge, Hiera-picra, Podophyllum;
Arum maculatum (Lords and Ladies); Camphor; Cantharides (Spanish-fly);
Cocculus Indicus;
Digitalis; Hellebore, Veratria, and Sabadilla;
Hemlock Poisoning;
Laburnum; Lobelia (Indian Tobacco);
Meadow Saffron (Colchicum); Nightshade; Privet Berries; Pulsatilla and Poke Berries;
Tobacco; Turpentine; Virginia Creeper; Yew Berries;
Poisonous Clothing, Wall-papers, Hair Dyes, and Cosmetics.
Poisonous Food.

Classification of Poisons.—Poisons are substances which are capable of acting injuriously on the body and destroying life, either by their direct chemical action on the part to which they

are applied, whether external or internal, or indirectly by gaining access to the circulation and acting on the various tissues and organs of the body. This is a very broad way of putting it, but poisons are so numerous and their effects so diverse that it is not easy to define very strictly what a poison is. The Greek word for poison is *toxicon*, and the poisonous effects of a substance are called its toxic effects, while *toxicology* is that special department of science which makes poisons and their effects its study, a toxicologist being one engaged specially in such work. The general definition which has been given of a poison embraces many substances not readily occurring to one's mind when the word poison is used. It includes substances not generally thought of as poisons when used in an ordinary way. Thus alcohol is a poison within the scope of the definition, though it only becomes so when used beyond certain limits. But then the dose has nothing to do with the inclusion or exclusion of any substance, for while a single drop of pure prussic acid will cause death, and the $\frac{1}{20}$ of a grain of aconitine, the active principle of aconite (monkshood), 60 drops is the smallest quantity of laudanum known to have caused death in an adult. Then the general definition allows room for the old adage, "What is one man's meat is another man's poison." Certain articles of food act constantly on some people like irritant poisons, notably shell-fish, but also other quite ordinary kinds of food, such as mutton and eggs; and there are now included as poisons certain substances produced in animal food kept for a long time excluded from the air. The exact nature of these substances has not been determined, but the term *ptomaines* has been applied to them, from Greek *ptōma*, a dead body, since it is dead animal matter in a state of decay in which they are produced. Many instances of poisoning arising from the eating of tinned meats are attributed to the production of these substances, not to the introduction from without of any injurious substances. Owing, therefore, to the diverse character of poisons there is some difficulty in arranging a suitable classification. One might consider their chemical constitution and arrange them accordingly, for example into those belonging to the class of inorganic substances, and those belonging to the class of organic substances. The inorganic substances might be further subdivided into poisonous gases, such as carbonic acid gas, carbonic oxide, sulphuretted hydrogen, &c.; acids, such as nitric, sulphuric, hydrochloric; metals, such as lead, arsenic, mercury, antimony; and non-metals, such as phosphorus. Belonging to the organic class are opium, chloral, alcohol, prussic acid, strychnine, belladonna, which it would be difficult still further to subdivide. It is clear that any such classification would be of no practical use. If poisons could be arranged into well-defined groups, according to their effects upon the body, each poison of one group exhibiting more or less similar symptoms to the others of the same group, and similar treatment being required for all the poisons of one group, then such a classification would be of the greatest possible benefit, because it would simplify the recognition of the kind of poison used in any particular case, and a knowledge of the principles of the grouping would be almost equivalent to a knowledge of the mode of treating any cases that might arise. Such a classification has been attempted, but only in a very general way, for the great diversity of action of the different poisons makes it impossible to effect it more accurately. Moreover, marked differences in the effects one and the same poison produces on the body are observed corresponding to the quantity of poison administered, its state of concentration or dilution, and the condition of the individual at the time of partaking of it. For example, the mineral acids given in their concentrated form produce, immediately on being swallowed, painful burning sensations in mouth, gullet, and stomach, and by their powerfully corrosive action destroy the tissues with which they come into contact, so that death speedily arises, while one of the same acids given largely diluted would have none of these caustic effects, though remote effects on other organs might follow. Then again, the same dose of one poison, oxalic acid, for example, if given in concentrated solution, will produce signs of irritation and inflammation of the mouth, gullet, and stomach; but if given diluted with a large quantity of fluid or other liquid will produce no such symptoms, but in a brief time will cause death through its effects upon the heart and nervous system. If, then, we indicate a grouping of poisons according to their effects upon the body, it must be understood that such a classification is not by any means complete. This classification is one commonly used, and it includes at any rate the most of the poisons commonly known; it is the grouping into the two classes of **irritant or corrosive poisons and narcotic poisons.** Irritant poisons are those which set up irritation or inflammation of the throat, gullet, stomach, and bowels, which irritation is readily recognized by the symptoms

THE RESTORATION OF THE APPARENTLY DROWNED.

HOWARD'S METHOD

Plate XVIII.

The person is pressed face downwards over the clothes, rolled in a bundle and placed under the stomach, for the purpose of expelling any water that may have entered the stomach or lungs.

In the second position the rescuer spreads his hands over the under ribs, and pushing upwards, causes the chest to expand and air to enter the lungs. He then springs back into the upright kneeling posture and thus allows the chest to return to its former position, and the air to be expelled from the lungs. This movement should be repeated regularly 15 times per minute.

about to be described; and narcotic poisons are those which act upon the nervous system, inducing paralysis of the brain, insensibility, stupor, and death.

Symptoms of Poisoning.—Stevenson says that the general symptoms which should excite a suspicion of poisoning are the sudden onset of serious and increasingly alarming symptoms, in a person previously in good health, especially if a prominent symptom be pain at the pit of the stomach; or where there is complete prostration of the vital powers, a cadaverous expression of the countenance, an abundant perspiration, and speedy death. Now we have not quoted these sentences from Stevenson in order to indicate that, when such symptoms arise, the unskilled person is immediately to jump to the conclusion that poison has been at work, but rather as a warning against the coming to such a hasty conclusion. For all these general symptoms that have been noted may arise, and do arise, in cases of natural disease. One has known a man, for example, suddenly seized with intense pain at the pit of the stomach while he was actively engaged, apparently in good health, in the transaction of business. Great pallor, most alarming prostration, immediately occurred, and his countenance bore a look of intense anxiety. Unable to assist himself to the slightest degree, he was conveyed home, and was dead fifteen hours later, having never recovered the state of collapse into which, all in an instant, he was plunged. Now, anyone who had read the sentence, in which have been noted the general symptoms, which should excite suspicion of poisoning, would say, "Here surely is a case which accurately answers to the description—this man must have been poisoned." But no such suspicion ever occurred to anyone. The explanation of the whole case was that the man had suffered from a chronic ulcer of the stomach, of which, however, there had been almost no symptoms, so that he thought himself in average health, but it had gradually burrowed its way through the coats of the stomach; and on the day in question he suddenly slipped his foot, made a quick, strong effort to recover himself, and the sudden strain caused rupture of the ulcer—a tear of the stomach wall—to occur, and to be followed by extensive bleeding, of none of which, however, was there any external sign. The sudden pain was at the moment of rupture, and the intense prostration was the result of the internal bleeding. We wish, therefore, to emphasize as strongly as possible the fact that natural diseases present symptoms utterly indistinguishable in many cases from those of poisoning, at least utterly indistinguishable to an unskilled person, however much aided by the reading of descriptions and the study of authorities. Nay, in many cases it is quite impossible for a medical man, however skilled, to distinguish with certainty between natural disease and poisoning. Whenever his suspicions are aroused, he seeks other evidence, evidence from circumstances in the surroundings of the patient, and chemical evidence derived from examination of vomited matters and so on. Illustrations of this fact could be indefinitely multiplied. In a recent case, which excited great public interest, the evidence of medical experts, experts on the subject of poison, was equally emphatic on both sides of the case, the one maintaining all the symptoms were those of poisoning by arsenic, the other that they were no more than symptoms of inflammation of stomach and bowels. Let no one, therefore, come to hasty conclusions as to the causes of an illness, still less be unwise enough to utter suspicions aloud. If symptoms seem to be suspicious, rather let expert medical aid be immediately summoned, and let the person communicate privately, if need be, to the doctor any painful surmises that may have been aroused.

The symptoms of the two common kinds of poisons—irritant and narcotic—will, if now given, be a sufficient general indication of the nature of symptoms of poisoning; and special symptons will be given in detail in speaking of special poisons, later in the section.

Symptoms of Irritant and Corrosive Poisoning.—The symptoms of irritant poisoning are due to the caustic or burning effect of the poison on the mucous membrane of the parts with which it comes into contact, the lips, mouth, throat, stomach, and bowels—if it reaches that length; and the effects are due to the immediate chemical action of the substance. There is a hot, acrid, burning pain and sense of constriction on lips, mouth, throat, and gullet. The feeling of burning from the gullet downwards to the stomach is very great, and thirst is intense. In the stomach there is a sharp burning pain, which extends more or less all over the belly, and pressure on the surface of the belly produces a feeling of tenderness, and speedily of actual pain. The pain of colic is relieved by pressure. Vomiting occurs, usually quickly, and the vomited matters increase the acrid sensations in the gullet and mouth. At first the material vomited is simply the contents of the stomach, but as the vomiting persists the

material becomes bilious and mucous, and later may contain blood, which, however, may not be red in colour, but brown or black by the action of the contents of the stomach. The pain over the belly rapidly increases, and the belly becomes swollen, so much sometimes as to make breathing difficult. The vomiting may be followed by purging, if the poison has reached the bowel, and the motions are watery, frequent, accompanied by painful cramps, and perhaps containing blood. The urine is scanty, passed with pain and difficulty, or not passed at all. If the action of the poison has been quick and powerful the patient may show speedy signs of collapse, in weakness and rapidity of pulse, in short shallow breathing, in cold clammy skin and pinched features; and death may occur in from six to twenty-four hours. If the action of the poison has been less immediately and powerfully active, a stage of inflammatory fever, with flushed face and bounding pulse, may precede the stage of collapse and sinking.

The symptoms vary more or less in detail according to the actual poison. To the class of irritant poisons belong:—

Sulphuric Acid (Oil of Vitriol).
Hydrochloric Acid (Muriatic Acid, Spirit of Salt).
Nitric Acid.
Carbolic Acid.
Oxalic Acid.
Creasote.
Caustic Potash.
Caustic Soda.
Caustic Lime.
Caustic Ammonia.
Arsenic.
Antimony.
Copper.
Lead.
Mercury.
Phosphorus.
Silver.
Zinc.
Croton-oil.
Elaterium.
Gamboge.
Spanish-fly (Cantharides).

While all of these are irritant some are, besides, powerfully corrosive, all the acids, for example, the caustic soda, potash, lime, and ammonia, and corrosive sublimate—a preparation of mercury. In strong solutions they produce immediately destruction of a layer of the mucous membrane of lips, mouth, &c., more or less deep, which is quite visible to the naked eye. In the case of nitric acid it is a yellow stain, in the case of sulphuric it is white, and whitish or brown in the case of hydrochloric; that of carbolic acid is white, while caustic potash and soda produce a white drawn appearance. Nitric, hydrochloric, and sulphuric acids produce also yellow, red, or brown stains on the clothing, when any has dropped upon it. The acids and other caustic substances may be dilute enough not to produce such scars, but yet to occasion the irritating effects, and in the case of the metallic poisons it is the irritating effects alone that are pronounced. In the case of the marked corrosive effects being produced, shreds of the destroyed mucous membrane are vomited with blood more or less altered.

The diseases which are apt to be mistaken for poisoning from such substances are inflammation of stomach and bowels, ulcer of stomach and bowels, colic, and cholera; but when a corrosive substance has been swallowed the marks on lips, mouth, and throat will clear up the nature of the case.

When recovery from the immediate effects of the poison occurs, death may yet ensue from subsequent ulceration and exhaustion, or from constriction of gullet and stomach, resulting from the destruction wrought by the poison and the subsequent process of healing.

The Symptoms of Narcotic Poisoning are best seen in the case of opium, morphia, or laudanum poisoning, where there are drowsiness, passing on to deep insensibility, snoring breathing, livid countenance, cold clammy skin. In some cases—poisoning from belladonna and henbane, for example—there is delirium.

The chief narcotic poisons are:—

Alcohol.
Belladonna.
Chloral Hydrate.
Chloroform.
Conium.
Digitalis.
Hyoscyamus or Henbane.
Indian Hemp (*Cannabis Indica*).
Morphia, Opium, and their preparations.
Prussic or Hydrocyanic Acid.
Stramonium (*Thorn-apple*).

A third set of poisons has been called **narcotico-irritant**, because they produce effects similar to both irritants and narcotics. They excite vomiting and purging like the former, but the symptoms go on to stupor, unconsciousness, convulsions, or paralysis. To this class belongs a very large number of vegetable poisons, including croton-oil, colchicum, laburnum, woody nightshade, and many other substances belonging to the vegetable kingdom, including muscarin, the poisonous active principle of poisonous mushrooms.

Poisons, developed in preserved food, are of this class, the sickness, vomiting, purging, weakness, and exhaustion which arise, some time after the food has been taken, yielding subsequently to symptoms indicating action on the brain and nervous system.

The Treatment of Poisoning.—Later in this section, and under the head of each poison, the appropriate treatment in detail for each kind of poison will be given separately, but it will be well to indicate here the general principles of treatment common to all cases. If the poison has been swallowed it passes into the blood from the stomach. Clearly if it can be removed from the stomach before it has had time to be absorbed into the blood, much of the risk will be removed. There are two ways of doing this:

By the use of the stomach-pump,
By substances which cause vomiting—emetics.

In every case, almost without exception, the removal of the poison from the stomach is the first thing to be done. If treatment be begun immediately after the poison has been taken, this may be so effectual that not the slightest sign of poisoning may arise. The author once had to deal with a woman who had drunk the whole contents of a sixpenny packet of rat-poison (arsenic), and who immediately thereafter confessed what she had done. Treatment was begun within 10 or 15 minutes thereafter, and so effectually was the stomach washed out that not the slightest symptom of any disturbance whatever appeared.

The **stomach-pump** is commonly only in the hands of a doctor, and need not be described in detail here. It consists of a long gum-elastic tube, about the thickness of one's finger. It is passed through the mouth into the throat, being directed well back, and down the gullet to the stomach. A small pump is fixed at the mouth end, and water injected till the stomach is well filled, when, by means of a flute-key arrangement, the action of the pump is reversed, and the stomach emptied again. A single-action pump, however, is not unsuitable, which permits the stomach to be filled but has no arrangement for reversing the action without unscrewing the pump portion. The stomach can, however, be washed out by a much simpler contrivance, a simple gum-elastic tube to which a funnel can be attached at the outer end, and water thus run into the stomach. If, when the tube is full, the end is closed to keep it so, and then bent downwards sufficiently, and the end allowed to open, the tube will act as a syphon and drain off the water till the stomach is empty. The outer end of the tube should then be raised, the funnel adjusted, and the stomach filled again, and afterwards again emptied. For it is not enough to empty the stomach, it should be washed out to prevent any portion of the poison being left adherent to the stomach walls to be afterwards absorbed. In an emergency a stomach-tube can be easily devised out of 6 or 8 feet of ordinary thick india-rubber tubing. It is passed down into the stomach, and a funnel attached to the outer end as already indicated. If no filler can be had the ivory end of a syringe could be attached to the outer end of the tube, and by working the syringe the water can be injected into the stomach.

The only cases in which it is not allowable to use the stomach tube or pump are those in which corrosive poison has been swallowed, as there is great probability of some parts of gullet or stomach being so softened or destroyed that there is risk of the tube being pushed through the wall.

As to **emetics**, a great variety may be used. Those almost always at hand are salt and water, and mustard and water:—two table-spoonfuls of common salt in a tumblerful ($\frac{1}{2}$ pint) of tepid water, or a dessert-spoonful of mustard in a tumbler of water. If that is not effectual in a few minutes it may be repeated. The other common emetics are:

30 grains Sulphate of Zinc in a little water,
30 grains Ipecacuanha Powder in a little water,
2 table-spoonfuls of Ipecacuanha Wine in a little water.

The mustard and water may be given first, the mustard being stimulating besides causing vomiting, and it could be followed immediately by a mixture of 30 grains sulphate of zinc and 30 of ipecacuanha powder. Any one of these is quite safe in the hands of an unskilled person, but tartar emetic or antimonial wine should not be resorted to by inexperienced persons. (Emetics are considered in detail on p. 850.) In the absence of any of these substances copious draughts of warm water are to be given, tumblerful after tumblerful, till vomiting occurs. The throat may be tickled with a feather, or the finger passed down to excite retching.

The second thing to do in cases of poisoning is to endeavour to neutralize any direct chemical effect which the substance might have on the stomach walls. In the case of acids this is done by giving draughts of alkaline substances in water, bicarbonate of soda or potash, magnesia, chalk, whiting, plaster from the wall; and, in the

case of caustic potash or soda, vinegar in water, lemon juice in water, &c. It is well not to give the neutralizing substances in great quantities all at once, else the enormous development of gas which would occur might be hurtful, especially if any part of the walls of the digestive canal had been seriously damaged by the poison, but in small quantities frequently repeated.

A third step to take is to protect the walls of the stomach as far as possible from the action of any irritating agent, by drinking freely of bland fluids, like white of egg beat up in water, gum and water, oil, milk, &c.

All these steps have for their object protection of the mucous membrane from direct action of the poison. But if the poison has been taken some time before treatment was commenced, some of it must be already absorbed into the circulation, and will not be reached at all by these measures. Nevertheless even though the poison has been taken some time before, it is well to empty and wash out the stomach, in one way or another, for although the whole of it cannot be recovered, it may not be all absorbed. Some of it may yet be lurking about the coats of the stomach, and if allowed to remain will gradually be absorbed, intensifying all the symptoms. The stomach, therefore, ought always to be washed out to prevent this. Again, there are many ways in which poison may gain entrance to the body besides by the mouth and stomach. The poison may have gained entrance by the skin, it may have been rubbed in with liniment or ointment, or it may have gained entrance by a wound, or it may have been administered by hypodermic injection. In all these cases cleaning out the stomach can have no effect on the poison already circulating in the blood. For such cases it is necessary to employ an antidote, if an antidote be known for the particular poison.

Antidotes (Greek, *antidotos*, a remedy) are substances which counteract or prevent the action of a poison. This they may accomplish in the stomach before the poison is absorbed. Thus if snake poison be mixed with a solution of permanganate of potash, it ceases to have any poisonous effect; if white of egg and corrosive sublimate (perchloride of mercury) be mixed, an albuminate of mercury is formed, which is insoluble and cannot be absorbed; arsenic and iron form an insoluble compound, and so a solution of freshly prepared oxide of iron is given in arsenical poisoning. In such cases it becomes necessary to wash out the stomach, after the antidote has been given, to expel the now insoluble poison. But some antidotes also act by producing on the various organs of the body effects which counteract those produced by the poison. Substances are, therefore, given which follow up the poison in the blood and prevent it producing its usual results. Substances which thus hinder one another's effects are said to be **antagonistic drugs.** Thus belladonna is an antidote against opium poisoning, and, of course, opium to belladonna poisoning, chloral hydrate is to some extent an antidote to strychnine. In cases of poisoning, then, besides washing out the stomach, or exciting vomiting, giving substances to neutralize any corrosive action, supplying bland and soothing substances to the stomach, it is necessary to administer, if possible, an antidote to the poison.

Besides the various steps that have been related, others must be taken, varying according to the circumstances of the case. The person should be kept warm by means of warm clothing, warm rubbing, &c. If shock has been produced, if the heart and breathing are feeble, the skin cold and pale, the general treatment described under Shock, p. 990, must be undertaken. Again, if the person be drowsy, every effort must be made to arouse him—douches of cold water are useful for this purpose, stimulants may be necessary, and commonly are. Hot coffee is one of the best, but hot alcoholic stimulants may be advisable.

POISONING BY CORROSIVE SUBSTANCES—ACIDS — CAUSTIC ALKALIES — LUNAR CAUSTIC—IODINE AND PHOSPHORUS.

Poisoning by Corrosive Acids.—These acids are:—

Hydrochloric Acid or Spirit of Salt or Muriatic Acid,
Nitric Acid or Aqua Fortis,
Sulphuric Acid or Oil of Vitriol,
Carbolic Acid, Phenic Acid or Phenol,
Acetic and Tartaric Acids.

The symptoms of poisoning by these acids have been already described under irritant poisons on p. 1015. They are, briefly, immediate burning pain in mouth, gullet, and stomach, great thirst, vomiting of intensely acid material, the food vomited being mixed with altered blood. Inflammation of the bowels arises and the belly becomes swollen and tense. There is likely to be constipation and suppression of urine. The stain in the mouth is yellow in the case of nitric acid, brown in the case of hydrochloric, and white in the other cases. The shock is marked

by weak pulse, and cold clammy skin; difficulty of breathing and swallowing are marked. In the case of carbolic acid the urine becomes dark, even black in colour. A similar dark-coloured urine is sometimes passed in surgical cases, owing to absorption of the carbolic acid used for the dressings, but it is not usually attended by other symptoms.

In the case of each of the strong acids one to two tea-spoonfuls can prove fatal, but recovery has followed the taking of even half an ounce.

Treatment.—(1) Do not attempt to use the stomach-pump, nor to induce vomiting; the damage to the parts may be so great that this would be accompanied by risk.

(2) Give immediately large quantities of water to dilute the acid, containing also some alkaline material to destroy the acid. Soapy water, water with bicarbonate of potash, bicarbonate of soda, common washing soda, magnesia, ammonia, chalk or lime water, whatever of this kind is at hand, will suit.

(3) Follow up this with bland drinks which will soothe the corroded membrane, white of egg drink, gummy water, milk, oil freely, and so on.

(4) Maintain the warmth of the body, restore the patient from shock (see p. 990), and subsequently give nourishing and stimulating food.

In the case of carbolic acid Epsom salts or Glauber's salts are to be given—½ ounce in ½ pint of warm water. They form sulpho-carbolates with the acid, which, though absorbed, are harmless. Large quantities of Epsom salts or Glauber's dissolved in tepid water may be used to wash out the stomach, and the other treatment is the same.

Oxalic Acid Poisoning.—Oxalic acid or the oxalate of potash—salts of sorrel—is sometimes taken by mistake. It produces symptoms identical with those of the corrosive acids named, and it may cause death within ten minutes of its being taken. Besides the corrosive effect it has a powerfully depressing action on the heart, causing feeble pulse and excessive languor, and it is these nervous effects that cause the speedy death.

A quarter of an ounce has killed, but recovery from twice that quantity has occurred.

Treatment.—(1) Give freely chalk, lime, or whiting. The lime or whitewash from walls may be used, lime-water also, or tea-spoonful doses of the saccharated solution of lime frequently repeated. These lime preparations form insoluble salts with oxalic acid, but soda, potash, magnesia, ammonia form soluble salts, and are to be avoided.

(2) Give an emetic to clear out the stomach after the lime draughts.

(3) Clear out the bowels with an ounce of castor-oil.

(4) Maintain warmth; and supply stimulants, if necessary.

Acetic Acid.—Glacial acetic acid would cause corrosion like the acids already named. Cases of poisoning are to be treated exactly as those of the other acids.

Tartaric Acid has been taken in mistake for a saline medicine, and one ounce of it has caused death. The symptoms are great pain in the abdomen, convulsions, collapse, and death.

Treatment.—Large draughts of water containing lime, whitewash, or whiting should be given, or tea-spoonful doses, frequently repeated, of saccharated solution of lime. Soda, potash, and ammonia are to be avoided. The bowels are then to be cleared out by a full dose of castor-oil.

Poisoning by Caustic Alkalies (Soda and Potash).—Solutions of these caustic substances are sometimes taken by mistake. The impure carbonate of potash—pearl ashes—used for cleaning may be accidentally taken, and caustic lime may be similarly swallowed. In such cases loose stools, purging, bloody motions are the rule, while in the case of acids it is constipation. Otherwise the symptoms are similar to those produced by corrosive poisons.

Treatment.—(1) Do not use the stomach-pump, but give copious draughts of water, vinegar and water, acetic acid in water, orange lemon or lime juice, citric or tartaric acid in water, and so on, to neutralize the soda or potash, and give such in small quantities frequently repeated—repeated every few minutes.

(2) Subsequently give the bland drinks of gummy water, white of egg drink, olive-oil, &c., as directed for acids.

Saltpetre or Nitre (*Nitrate of Potash*) may cause fatal poisoning in a one-ounce dose. The symptoms are those of an irritant poison, with subsequent tremors, convulsions, and death from collapse. In this case use the stomach-pump or an emetic, and then use warmth and stimulants to ward off the shock, giving bland drinks also as before.

Ammonia, in addition to producing effects akin to caustic alkalies, acts upon the lungs and air-passages, producing suffocative cough, often

loss of voice, and sometimes death by the irritation of lungs and air-tubes. In addition to the treatment advised for soda and potash, employ inhalations of steam. An operation may be necessary to relieve the breathing if the swelling at the top of the windpipe be very great.

Lunar Caustic sometimes accidentally passes down into the stomach when being used for touching an inflamed throat. It is a preparation of silver—nitrate of silver, but it may be well to consider it here, alongside the other caustic substances. Symptoms of irritant poisoning are produced, pain, vomiting, &c., and the vomited matter is of a flaky white appearance, and turns brown or black on exposure to light.

Treatment.—(1) Give large draughts of common salt dissolved in water. This forms with the caustic the insoluble chloride of silver.

(2) Then give an emetic, ipecacuanha (20 grains), sulphate of zinc (20 grains) or mustard in water, to empty the stomach.

(3) Soothing drinks, oil, gummy water, white of egg in water, barley-water, are then to be supplied.

Iodine, a non-metallic element, occurring in crystalline scales, may be most conveniently considered in this group. It may be taken in the form of the scales, by mistake for another substance, or as the solution—tincture of iodine. Symptoms of irritant poisoning are produced, and faintness, giddiness, and convulsions may occur. Iodine strikes a blue with starch, and the vomit may consequently be blue.

Treatment consists in (1) the use of the stomach-pump, or an emetic of mustard (table-spoonful) in a tumbler of water, or 20 grains of sulphate of zinc or ipecacuanha powder in water.

(2) Give freely drinks of starch and water, arrow-root, white of egg, gruel.

(3) Apply poultices over the stomach to relieve pain.

The effects produced by excessive doses of iodide of potassium are called **iodism**, and are described on p. 825.

Phosphorus poisoning may arise from the solid phosphorus, from the use of rat paste—phosphorus paste—in children from the sucking of lucifer matches; and chronic cases are frequent from the inhalation of phosphorus fumes in match manufactories.

Symptoms of irritant poisoning, colicky pains, vomiting, diarrhœa may be more or less marked. The vomited matters, sometimes the urine, are luminous in the dark; and the breath has a peculiar garlicky odour. The liver is specially affected, is tender, and enlarged, and in a few days jaundice occurs; the urine is scanty, high-coloured, and contains bile. There may be bilious vomiting; there is headache; and the patient is dull and sleepless, perhaps in muttering delirium, with weak, fast pulse, death occurring in from two to ten days of exhaustion. The dose which will produce such effects is about ½ grain. Sometimes there is a marked tendency to bleeding, the vomit and stools being bloody, bleeding from the nose occurring, and bleeding taking place in the skin producing the appearances of bruising. In other cases nervous symptoms are most pronounced, mental failure, prostration, convulsions, and stupor. One marked result in chronic cases is decay of the teeth, and death (necrosis) of the lower jaw-bone.

Treatment.—In acute cases (1) give an emetic of 20 grains powdered ipecacuanha or sulphate of zinc in water.

(2) Give 10 to 20 drops of oil of turpentine, frequently repeated (every half hour for a time)—the French oil of turpentine specially.

(3) Give ½ oz. Epsom salts as a purge.

(4) Administer in plenty gummy drinks, *but no oils,* as they dissolve the phosphorus and make it more readily absorbed.

Poisoning by Lucifer Matches is to be similarly dealt with.

METALLIC POISONING.

The metals which most frequently give rise to cases of poisoning are:—

Antimony,
Arsenic,
Copper,
Lead,
Mercury.

The symptoms they produce are generally those of an irritant poison (p. 1015).

Antimony—Tartar Emetic.—Tartar emetic produces speedy and violent vomiting, and poisoning by one large dose is comparatively rare, since the expulsion of the poison from the stomach is quickly secured. The vomit is at first of food; then it becomes bilious, and finally tinged with blood. There is pain in the abdomen; a metallic taste is felt in the mouth, and a burning pain and feeling of constriction, extending to the throat and gullet. Just preceding

the vomiting there is intense prostration, and faintness, accompanied by weak pulse and feeble breathing, while the skin is cold and bathed in a cold perspiration. Later the bowels become affected and a copious watery discharge comes from them, resembling the rice stools of cholera, while the urine becomes scanty and may be suppressed. The patient is excessively weak, muscles are relaxed, and cramps of the extremities sometimes occur.

A single large dose may or may not prove fatal according to the rapidity with which vomiting occurs. But recovery has occurred after half an ounce had been taken, though 10 to 20 grains would likely cause death in a few hours; and 2 grains have proved fatal; while three-quarters of a grain have killed a child.

Much smaller quantities than those named will cause death if they are given in small frequently-repeated doses. Similar symptoms occur—prostration, sickness, vomiting, purging, profuse perspiration, impaired breathing, feeble pulse; and death occurs by exhaustion. The symptoms have marked resemblances to cholera states and conditions of chronic catarrh of the bowels. Sickness, vomiting, and purging also occur in cases of arsenical poisoning, but without the intense prostration and profuse sweating characteristic of tartar emetic.

Treatment.—(1) Emetics are not needed, but, if it can be done, washing out the stomach with the syphon-tube will be advantageous.

(2) Tannic and gallic acids form insoluble preparations with tartar emetic; therefore give half a tea-spoonful of either of these in water, and repeat it if it be vomited. Substances containing tannin will also be valuable as substitutes—decoction of oak bark, tincture of cinchona, strong tea infusion, coffee, and these should be given in large quantities till vomiting ceases.

(3) Thereafter give soothing drinks—egg drink, barley or gum water, arrow-root, &c.

(4) To overcome the depression give stimulants, hot, in small quantities repeated, and maintain the patient's warmth by hot bricks, hot drinks, &c.

(5) Nourishing and stimulating injections may be given (p. 873) if the patient seems to be in risk of collapse.

Arsenic.—Poisoning by arsenic, whether by a single large dose or by repeated small doses, whether the poison be given by the mouth or in any other way, exhibits signs of irritation of the stomach and bowels. In the case of large doses the symptoms are acute, and the patient dies within from eighteen to seventy-two hours of the administration. Within half an hour or an hour of the drug being taken, depression comes on; and a severe burning pain is felt at the pit of the stomach, which is increased by pressure on that region. Vomiting next occurs, at first only of the contents of the stomach; but it persists in spite of the stomach being emptied, and bile appears in the vomit owing to the retching; and sometimes the material is streaked with blood. There is also purging, accompanied by pain and violent straining at stool, and blood may appear in the motions. The throat is dry and burning; and thirst is great. The depression and faintness are marked; the skin is cold and clammy; pulse weak and irregular. There may be retention of urine; and a rash may appear on the skin. In cases of chronic poisoning there are loss of appetite, sickness and vomiting, a feeling of tenderness at the pit of the stomach, thirst, dryness of the mouth, redness of the lining membrane of the nostrils, puffy eyelids and reddened eyes, silvery-looking coating on the tongue, headache, irritability of the bowels manifested by frequent slimy motions perhaps mixed with blood, muscular weakness and sometimes even paralysis, beginning with the legs, dry irritable scaly skin, and steady loss of flesh. Death usually occurs by exhaustion.

Death has occurred from 2½ grains of arsenious acid—white arsenic—contained in 2 ounces of fly-water, and from ½ ounce of Fowler's solution of arsenic, which is equal to 2 grains of white arsenic, and death may occur, owing to exhaustion, from a single large dose many days after its administration.

The chronic forms of arsenical poisoning, while they may result from the frequent administration of small quantities, may also be due to the inhalation of dust from fabrics coloured by arsenical dyes, especially green, and to vapour of the poison from other articles. Thus arsenical pigments are to be found in articles of dress, in wall-papers, in artificial flowers, floor-cloths, book-bindings, &c., and it is to be remembered that many fly-papers and rat poisons contain arsenic.

Treatment.—In acute arsenical poisoning—

(1) Ensure thorough emptying of the stomach, and, if possible, washing out of the stomach. This is best accomplished by the stomach-pump or syphon-tube. Failing these, give mustard and water (a table-spoonful of mustard in a tumbler of water), or sulphate of zinc (20 grains) in water, and administer

copious draughts of hot greasy water, salt and water, effectually to clear out the stomach.

(2) Give as an antidote the hydrated peroxide of iron. This is prepared by adding half an ounce of carbonate of soda to an ounce of liquor of the perchloride of iron, or the ordinary tincture of steel. This should be strained through a handkerchief and diluted with hot water. Unlimited quantities may be given. Failing this, repeated doses of one ounce of dialysed iron should be given, or repeated doses of magnesia.

(3) Gummy drinks, barley-water, white of egg and water, linseed tea, should follow the antidote.

(4) Prostration is to be overcome by the free use of stimulants, and by the maintenance of the warmth of the body.

(5) Large doses of castor or olive oil, or a mixture of oil and lime-water, should follow up the above procedure.

In cases of chronic poisoning let the source of poisoning be discovered. Let the wall-paper be examined. Arsenic is not confined to green wall-papers. If the cause cannot be found and removed, let the person seek change of air. The use of quinine and iron tonics and warm baths will promote recovery.

Copper.—Blue-stone, or blue-vitriol, is the sulphate of copper, and verdigris the subacetate of copper. In the case of either of these being accidentally or intentionally swallowed, symptoms of irritant poisoning arise—a metallic taste in the mouth, thirst, sense of constriction and burning in the throat, sickness and vomiting, colicky pains, purging with straining, suppression of urine, hurried breathing, quick feeble pulse, headache, giddiness, stupor, perhaps convulsions. Death may take place within a few hours. The fatal dose of either of the compounds named is from half an ounce upwards.

Chronic forms of copper poisoning may occur from the use of pickles coloured green (p. 600) by the metal, by the use of acid fluids which have been in contact with copper vessels, and it may occur among workers in copper or bronze.

In cases of copper poisoning the vomited material has a greenish or bluish colour which becomes bright blue on adding ammonia.

Treatment in acute cases:—

(1) Empty the stomach by the stomach-tube or an emetic, mustard (tea-spoonful) and water, or ipecacuanha powder (20 grains) in water.

(2) Give white of egg switched in water and milk in large quantities to precipitate the copper.

(3) The after administration of barley-water, arrow-root, gruel, in quantity is to be carried out.

In chronic cases the person should be removed from the source of poisoning.

Lead Poisoning.—The acetate of lead—sugar of lead, the carbonate—white-lead, and Goulard's lotion—solution of the subacetate, have been taken by mistake in poisonous quantity. An ounce of either of the two powders is usually recovered from, and three-quarters of a pint of the lotion have not proved fatal, and cases of acute poisoning are rare. The chief symptoms are dryness of throat, thirst, metallic taste in the mouth, colicky pains chiefly in the neighbourhood of the navel, cramps in the legs, marked constipation, paralysis of the legs, and convulsions. It is the chronic cases that are numerous. They are frequent among workers in lead, plumbers, type-founders, compositors, among workers in lead pigments, painters, artists; and they are often due to contamination of water or other liquids, used for drink, by contact with lead pipes, leaden cisterns, leaden vessels, leaden taps. Cider has been contaminated owing to the glaze in the jars containing lead. Glazers of cards and workers in Brussels lace are said to suffer, and lead poisoning has resulted from the frequent use of hair dyes and cosmetics of which some preparation of lead was an ingredient. Shot used for cleaning bottles has contaminated the drink afterwards kept in the bottles. The contamination of drinking water is considered on p. 642.

The two characteristic symptoms of lead poisoning are colic and "wrist-drop." The colic has been termed "painter's colic," "Devonshire colic," from its association with cider, and "colica Pictonum," from the inhabitants of Poictou, among whom lead poisoning was common owing to the use of lead salts for adulteration purposes. The pain occurs about the centre of the abdomen in spasms like colic, and the abdominal wall is hard and drawn in. The pain is relieved by pressure. The bowels are obstinately costive. The patient also suffers from a feeling of sickness; the tongue is coated, the breath foul; and the patient feels a sweetish astringent taste in the mouth. At the margin of the teeth and gums a blue or violet line is developed. The skin has a dull earthy look, and the countenance is anxious. The "wrist drop" is due to a paralysis of the

muscles which are situated on the back of the forearm and pull the hand backwards, so that when the arm is stretched out the hand drops and cannot be raised. The paralysis may extend to other muscles of the arm, and to the legs and trunk. Rheumatic pains in muscles and joints are common; irritability of temper, sleeplessness, melancholy, and other indications of affections of nerves occur. Blindness owing to wasting of the optic nerves may arise, and disease of the kidneys is sometimes a consequence. Abortion is common in women.

Treatment.—In acute cases—

(1) Empty the stomach by the pump or an emetic of mustard and water, or sulphate of zinc (20 grains), or ipecacuanha powder (20 grains) given in water.

(2) Give, as an antidote, some sulphate—Epsom salts (sulphate of magnesia) or Glauber's salts (sulphate of soda), half an ounce of either in water, or half a tea-spoonful of dilute sulphuric acid in water. Any of these, with a lead compound, forms sulphate of lead, which does not dissolve and is not absorbed into the blood.

(3) Follow up this treatment with bland drinks, barley-water, milk, white of egg in water.

(4) Poultices to the belly will help to relieve the pain.

(5) Five grains of iodide of potassium in water three times daily will help to get rid of any of the drug which has been absorbed into the system.

In cases of chronic lead poisoning—

(1) Remove the person from the contaminating influence.

(2) Give a purgative, the best being sulphate of magnesia, which may be repeated in one-ounce dose for several successive mornings.

(3) Give iodide of potassium in 5-grain doses, dissolved in water, five times daily, for two or three weeks to remove the lead from the system.

(4) Supply nourishing, easily digested food, cod-liver oil and malt, &c.

(5) Sulphur baths, electricity and massage to the paralysed muscles will aid materially in the restoration to health.

(6) Opium or morphia is often required to relieve the colicky pain. It may be given in the form of suppository.

Precautions against further lead poisoning must be taken. Lead-workers who have been affected will require to change their occupation. As preventative measures, lead-workers should be scrupulous in the matter of cleanliness, changing work-clothes when work is over, washing hands, using tooth-brushes, and so on, in order effectually to remove from their person any dust which may contain lead.

Mercury.—Metallic mercury is almost inactive, if not altogether so, so long as it remains in the metallic state. If some of it has been swallowed, and if, in its course through the intestinal canal, any of it undergoes chemical changes into salts of mercury—the oxide, for example—symptoms of poisoning may arise from the absorption of the salt. The chief poisonous preparation is the perchloride of mercury or corrosive sublimate, which is used in medicine as a drug, and in the preparation of lotions and ointments, and is now very largely used as an antiseptic, so that the opportunities for accident are numerous. Symptoms of poisoning may arise from its use in lotions as a dressing or an injection, and symptoms of poisoning are not uncommon from the use of mercurial ointment, which contains metallic mercury, but in a finely divided state. Calomel, the sub-chloride of mercury, may also give rise to poisoning. There are rare instances of the white and red precipitates causing death, and of other preparations of mercury also.

Of corrosive sublimate 2 to 3 grains are believed to be a fatal dose, though recovery from much larger doses has occurred; and of calomel 12 grains have caused death. In acute cases of poisoning death may occur in a few hours or not for several days.

Chronic poisoning from the inhalation of mercurial fumes occurs among workers in mercury—gilders, looking-glass makers, the makers of barometers and thermometers.

Acute poisoning from corrosive sublimate presents symptoms resembling those due to corrosive acids or alkalies (p. 1015). An intense burning sensation is felt in the mouth and throat, which appear white and swollen where the solution has touched. There is a feeling of constriction in the throat, and great pain in the stomach. Vomiting, painful straining, purging often with bloody motions, occur. The skin is cold, pulse feeble, breathing difficult, and other symptoms of collapse are present. Urine is suppressed and convulsions may occur.

In cases of chronic poisoning one of the chief symptoms is salivation, a constant flow of saliva from the mouth. The salivary glands are swollen and tender, so also are the gums and tongue; the breath is very fœtid; ulceration of mouth and throat may occur. Sickness, vomiting, colicky pains, general tremor of the muscles

—mercurial tremor—emaciation and exhaustion, occur. The trembling affects first the upper limbs, but extends to the rest of the body, and occurs only when the person exerts the muscles.

Treatment.—In acute poisoning—

(1) An emetic of mustard and water, or sulphate of zinc (20 grains), or powdered ipecacuanha (20 grains) should be given.

(2) As an antidote give the white of two or more eggs beaten up with water. The albumin forms with the mercury an insoluble albuminate of mercury. Failing white of egg, give flour made into a cream with water, arrow-root and water, barley-water, milk and lime-water. Then empty the stomach again.

(3) Stimulants may be necessary.

In chronic cases remove the person from the source of poisoning. Give iodide of potassium in 5-grain doses thrice daily, and when salivation is marked let some mouth-wash be used—glycerine and tincture of myrrh and borax, for example. Change of air and tonics are valuable; and for the tremors electricity and massage would be useful.

Silver.—Nitrate of silver or lunar caustic as a poison has already been considered among corrosive substances (p. 1020).

Zinc has been a cause of poisoning in the form of chloride of zinc, which is the active material in Sir Wm. Burnett's disinfecting fluid, one ounce of which contains 230 grains. Its symptoms are those of a corrosive poison, like corrosive sublimate.

Treatment.—(1) Warm solutions of carbonate of soda or carbonate of potash or common washing soda. The substance used must be dissolved in a large quantity of water and given freely. Phosphate of soda in plenty of water is also useful. These substances form insoluble salts of zinc.

(2) Milk and eggs in water, decoctions of oak bark, tannic or gallic acids, and strong tea are also to be given.

Sulphate of zinc (white-vitriol or white-copperas), which is given as an emetic in 20-grain doses, has in large doses caused death its symptoms being those of an irritant but not corrosive poison.

POISONING BY ALCOHOL.

Large doses of alcoholic liquors act like narcotic poisons, and may cause death within a few hours. The distinction between insensibility from alcohol and insensibility due to concussion of the brain, apoplexy, and other conditions is not so easily made as is supposed; and so far as immediate aid is concerned, is unnecessary, for the one case demands as careful attention as the other. The effects of drinking it is needless to state here. When a person lies "dead drunk," the face is usually flushed, though it may be pale, the lips are livid, the eyes red, and the pupils are commonly dilated, both equally, though sometimes they are contracted and unequal. The breathing is slow and snoring—stertorous is the technical word. The pulse is slow and laboured, and the skin pale, clammy, and covered with sweat. The temperature of the body is low, and the muscles are all relaxed. A person in this condition lying exposed to the weather, or even under shelter, but without warm coverings, is in grave danger. The loss of the body heat is greatly hastened by alcohol, as explained on page 673, and the exposure to cold may speedily cause death.

The surroundings will usually assist one to arrive at a decision. The proximity of a whisky bottle, the smell of the breath, and so on are useful guides; but they are not to be taken as decisive. A drunk man may have fallen and received a blow sufficient to cause concussion of the brain or fracture of the skull, and his state may be the combined result of alcoholic poisoning and brain injury. He may have been seized with a fit of apoplexy. Caution in coming to a conclusion is, therefore, necessary; and it is best to treat the person as if the condition were grave. Injuries to the head or other parts of the person should be looked for; if squinting were present, or the face were drawn to one side, indicative of paralysis, serious brain injury should be suspected. In opium poisoning the pupils are much contracted, while, as already said, in alcoholic stupor they are usually dilated and fixed.

Treatment.—In many cases it will suffice to bring the patient under cover, to place him in a comfortable position, to restore warmth by the use of friction to the surface of the body, by wrapping in warm blankets, and placing hot bottles at his feet, and then leaving him to sleep off the effects of his excess. In some cases this is not enough. Much spirit may still remain, unabsorbed, in the stomach to maintain and aggravate the condition, when the power of absorption returns. It is, therefore, customary, when the case is serious, to empty and wash out the stomach by means of the stomach-pump, or by means of an emetic, for which purpose a table-spoonful of mustard in a tumbler of warm

water is best for its stimulating properties. Then efforts to rouse the patient should be made. A douche of cold water is wonderfully effective, or flapping the skin with a wet towel; vigorous slapping of the soles of the feet with slippers is often effective when shouting, pulling, and pinching fail. Once roused, the patient should have hot coffee to drink, and if he can be roused enough to take "a good square meal," it has a remarkably sobering effect. Delirium and chronic drunkenness have already been considered on p. 104.

POISONING BY NARCOTICS AND OTHER NERVE POISONS.

Opium, and its active principle **Morphia,** are the chief narcotic poisons, and are responsible for a very large number of deaths annually. The preparations of opium are mentioned on p. 897. Besides laudanum — the tincture of opium—common preparations are nepenthe and chlorodyne, the latter of which contains about 2½ grains of morphia to the ounce, a quantity which has caused death; and it is necessary to remember that paregoric elixir, both the English and Scotch, contain opium as one of their chief ingredients. Children are peculiarly susceptible to the influence of opiates. "It is said on good authority that 15,000 children are killed every year by soothing syrups and other similar preparations" (Murrell). The chief of these are **Dalby's carminative,** which is said to contain about 4 drops of laudanum in each tea-spoonful, and 40 drops have proved fatal to a child; **Godfrey's cordial,** which contains ½ grain opium to each ounce, and against which fifty-six deaths in five years were recorded, the fatal dose for an infant being set down as one tea-spoonful; "Mother's Friend," eight or ten drops of which may be fatal; and **Mrs. Winslow's soothing syrup,** which contains morphia with essence of anise and syrup of balsam of tolu. **Black drop** is a preparation of opium with three or four times the strength of laudanum.

Of crude opium 4 grains have caused death, and the same result has followed from 2 drachms —120 drops—of laudanum. A single grain of morphia has proved fatal. These were cases of adults, but less than ½ grain of opium has killed a child, and 4 drops of laudanum was the cause of death of a child nine months old, while two drops have proved fatal in an infant five days old, and a seven days old child died from the effects of *one drop*. Recovery from large doses, under prompt and vigorous treatment, has often been achieved, and 4 to 6 grains of morphia ought to be recovered from in the case of an adult under good treatment.

Most cases of opium or morphia poisoning prove fatal in from six to twelve hours. A relapse and a fatal termination may, however, occur, after recovery seems to have set in.

The heads of the white poppy, decoctions or infusions of the seeds, leaves, and capsules—poppy-heads, the blossoms and fruit of the red poppy, and syrup of poppies, a sweetened decoction of poppy-heads, have all proved fatal to children, to whom they are not infrequently given as soothing preparations.

The symptoms of opium or morphia poisoning are giddiness, drowsiness, and tendency to sleep, coming on in from half an hour to an hour after the dose has been taken. At the very outset a state of excitement may arise, and a pleasant exhilaration. But if the dose is large this may not appear at all, or very briefly. When the dose is small this may be the main effect, and it is accompanied by wakefulness, and often marked itchiness of the whole skin. Such a state is usually followed by depression, a dull headache, loss of appetite, and a dry mouth. With the larger dose the stage of sleepiness is preceded by headache, a feeling of weight and disinclination for exertion in the limbs, and lessened power of feeling. The face is flushed, and may be dark in colour, and as the poison acts the eyes have a strained feeling, the pupils being much contracted. At first, when insensibility occurs, the person can be roused to answer a question, but immediately drops off to sleep again, and after a time it is difficult or impossible to wake him. As the unconsciousness deepens, the breathing becomes slow and noisy, the pulse faster and softer, the skin pale and livid, bathed at first in warm perspiration, but later cold and clammy. Breathing becomes slower, the intervals between each breath being much prolonged. The pupils are at this time much contracted and motionless. Death arises from failure of breathing, the pulse continuing often at a fairly good rate and moderately strong, even when the breathing seems about to stop.

This condition is distinguished from drunkenness by the pin-point pupils, and the smell of opium is usually marked in the breath.

Treatment.—If the drug has been taken by the mouth (1) it is desirable to remove any from the stomach that may yet be unabsorbed. The stomach-pump is the proper

means for this, since emetics often fail, because of the soothing effect already produced on the stomach. If any emetic be given it should be mustard (table-spoonful) in warm water (a tumblerful), or carbonate of ammonia (30 grains) in water.

(2) Give tincture of belladonna (30 drops) in water, or its active principle atropine, $\frac{1}{40}$ grain. The atropine will act more quickly if given by hypodermic injection, and the dose should be repeated every twenty minutes till signs of recovery show themselves.

(3) Rouse the patient by every possible means, shouting at him, pinching him, pulling his nose, by ammonia to the nostrils, flapping over bare arms and chest with a wet towel, or by a douche of cold water over his head. Keep him walking about as actively as possible.

(4) Give draughts of strong coffee or tea.

(5) Artificial respiration (p. 1011) may be necessary.

The Morphia Habit.—Persons who have found it needful to take opium or morphia for prolonged periods, for the relief of pain, become so habituated to the use of the drug that they are able to take ever-increasing doses, without producing more than pleasurable slumbers and relief of pain. Very large quantities thus come to be used in time, and when the need for the drug has passed away the person cannot give up its use without a most distressing struggle. De Quincey took nine fluid ounces of laudanum, equal to 333 grains of solid opium, daily, and other cases are recorded where as much as 16 ounces were taken daily of laudanum. Those who take such daily supplies are miserable, listless, dull, and unable to work until the usual dose has been taken, shortly after which they become lively, bright, and full of energy and life. But, when the effects have passed off, they are left again in a state of despondency and wretchedness. It requires time and patience to break off such a habit; and not many are found capable of it if left to themselves. A person should be placed in charge of nurses, if the habit is to be rapidly and effectually got rid of, and they must act rigidly on the orders given to them, and must be able to resist the commands and entreaties of the patient for his drug. Complete deprivation of the drug at once is advocated by some, strength being kept up by careful feeding, and stimulants if necessary, other symptoms (headache and sickness) being relieved by cold applications and ice to suck, and sleeplessness by warm baths, a single dose only being given if dangerous collapse threatens. Another method, and the one generally adopted, is to diminish the doses by infinitesimal amounts, so that the diminution is not observed by the patient. Meanwhile every effort is made to restore the shattered health of the patient. One of the most important means is by stimulating nourishing foods, cooked with skill. Tonics containing quinine and nux-vomica are to be given, and the bowels should be kept regular. Stimulants may be required. If so, they are to be used with great care, lest one form of indulgence is got rid of, only to yield to another. For sleep, 30 grains of bromide of sodium in water are given at bed-time. Massage and electricity will be valuable additions to treatment; and active occupation is most desirable. The patient, however, must be so constantly watched and supervised that it is impossible for him to obtain a surreptitious dose.

Chloral Hydrate poisoning resembles that of opium in many particulars. Deep sleep comes on quickly, with great muscular relaxation. The face is livid and bloated; breathing is much interfered with, slow and noisy; pulse is weak and quick. The temperature of the body falls to a great degree. The pupils are contracted while the patient is asleep, but, if he is roused, they dilate. Death occurs by failure of the breathing or the heart. Such a result has occurred from a dose of 30 grains, though recovery has taken place after 460 grains had been swallowed.

The treatment is the same as that for opium. The stomach should be emptied by the stomach-pump or an emetic. The heat of the body must be quickly restored by friction, hot bottles, hot blankets; and the patient must be roused and kept awake. Hot coffee is given to drink. The only substance approaching to that of an antidote to chloral hydrate is strychnine, of which 5 to 8 drops might be given by the mouth, or 15 drops of the tincture of nux-vomica. Artificial respiration may be necessary for hours to prevent failure of breathing.

Chlorodyne Poisoning is due to the opium contained in the drug, and the treatment is that of opium poisoning.

Prussic Acid or **Hydrocyanic Acid.**—This in its pure and undiluted state is one of the most deadly and rapid of poisons. A single drop will cause death. The vapour of the poison is also destructive to life. The undiluted acid is not obtainable, but two preparations are in use, the dilute acid of the British Pharma

copeia, which contains 2 per cent of the undiluted acid, and the dilute acid of Scheele, which contains 4 per cent. Twenty-five drops of the latter solution would, therefore, be the smallest fatal dose. Recovery, however, has taken place, under treatment, from $2\frac{1}{2}$ times this quantity. The drug acts with great rapidity, in its concentrated form practically instantaneously. Large doses of the Scheele's acid—3 or 4 drachms—would begin to act within 10 or 15 seconds, and 1 drachm—60 drops—within a minute. The symptoms, in cases where a fatal dose has been taken, are rarely delayed beyond 1 or 2 minutes, and death occurs within 5 or 10 minutes.

Symptoms.—When the dose is not so great as to cause death instantaneously, the symptoms are giddiness, mental confusion, difficult breathing, and slow irregular pulse. Insensibility then comes on, the pupils are widely dilated, the eyes open, fixed and glistening. Breathing is gasping, the effort to breathe out being prolonged. The face is livid, the skin cold and clammy, and violent convulsions may occur. There is often vomiting and involuntary emptying of the bowels and bladder. The jaws are firmly closed and the hands clenched.

Noyau (p. 668) contains prussic acid; **Cherry Laurel Water** and **Oil** owe their odour and active principle to prussic acid, of which the former contains $\frac{1}{4}$ per cent of the undiluted acid, and the latter about 3 per cent. The kernels of peaches, apricots, almonds, &c., contain the acid, and deaths have occurred from eating them (p. 580).

Cyanide of Potassium, a compound of prussic acid and potash, is much used in photography and electro-plating, and has proved fatal with symptoms of prussic acid poisoning.

Treatment must be very quick and energetic.

(1) Use the stomach-pump or secure vomiting by mustard (1 table-spoonful) in warm water, sulphate of zinc (20 grains), or ipecacuanha wine (two table-spoonfuls).

(2) Give stimulants instantly and freely, ammonia (15 drops) in water, brandy or whisky in water, and let ammonia be inhaled from a handkerchief, or use smelling-salts.

(3) Dash cold and hot water alternately over the head and chest of the person to stimulate the breathing.

(4) Resort to artificial respiration and maintain it steadily.

(5) Atropine has been urged as an antidote, $\frac{1}{50}$ grain injected under the skin to be preferred, or 15 drops tincture of belladonna by the mouth.

Alongside of prussic acid must go the **Essential Oil of Bitter Almonds**, which is from five to eight times as strong as the British Pharmacopeia dilute acid, and 17 drops of which have proved fatal, and the **Spirits of Almonds**, used for almond flavouring, which is about the same strength as the dilute pharmacopeia acid.

Aconite (*Aconitum Napellus*, Plate XIII., Wolf's-bane or Blue Rocket or Monkshood).—All parts of the plant are poisonous. The root has been taken in mistake for horse-radish; eating the fresh leaves has been the cause of children's death; for the plant grows wild everywhere. Medicinal preparations (see p. 834) have occasioned many deaths. The active agent is an alkaloid — aconitia. It is used in medicine chiefly in the preparation of an ointment for neuralgia, and it is the chief constituent in **Neuraline**, an application for neuralgia. Sixty drops of the tincture have proved fatal, though recovery has occurred after larger doses.

The **symptoms** are tingling of mouth, lips, and tongue, and a feeling of warmth at the pit of the stomach. Tingling extends to the whole body, followed by numbness and diminished sensibility of the skin. A feeling of faintness comes on; there is sickness and often vomiting. The heart's beats become weak and lessened in number; the breathing is shallow and infrequent; and deafness and dimness of sight arise. Convulsions may occur; death is due to prostration; but there is no disturbance of the intelligence, and the pupils are dilated.

Treatment.—(1) Use stomach-pump or emetic.

(2) To antagonize the poison give 4 drops solution of atropine by the mouth, or 20 drops tincture of belladonna. If the pulse improves give a second dose in half an hour, or give 20 drops tincture of digitalis, followed in two hours by a similar dose, if the pulse has improved with the first.

(3) Stimulants to be given freely, and the warmth of the body to be maintained.

The person should be kept strictly lying flat.

Atropia and Belladonna Poisoning.—Belladonna, Deadly Nightshade, or Dwale grows wild, and produces berries of a dark shiny colour, about the size of a cherry, marked with a deep central furrow (Plate X.). These berries have been eaten by children, and have even been cooked in a pie. The effects produced by any of the medicinal preparations, or

by using parts of the plant, are due to the active principle atropia. Recovery has taken place in the case of a child who had eaten fifty berries; death has been caused by a drachm of the liniment of belladonna, though recovery has taken place after much larger doses. The symptoms are heat and dryness of the throat and mouth, great thirst, absence of saliva, and difficulty in swallowing. The face is flushed a bright scarlet, the eyes are bright and sparkling, and the pupils widely dilated and insensible to light, while vision is blurred. The patient is excited and delirious; there is loss of muscular power. The skin is dry, and there is sometimes a rash like that of scarlet fever; and there is inability to pass water, though a frequent desire to do so. Drowsiness comes on; the breathing is hurried, and the pulse feeble. Convulsions occur, stupor, and death.

Treatment.—(1) Empty the stomach by stomach-pump, or by emetic of mustard, sulphate of zinc, or ipecacuanha.

(2) Administer as an antidote extract of physostigmine, the Calabar bean, of which $\frac{1}{4}$ grain in pill may be given every half-hour for several doses.

(3) Stimulants, whisky, brandy, hot coffee, are to be given freely, and the patient is to be kept warm.

(4) Artificial respiration may be necessary.

The prospects of recovery are always hopeful.

Calabar Bean (see p. 902) in poisonous doses causes loss of power in the legs, prostration, contracted pupils, and death from failure of breathing.

Treatment.—(1) Empty the stomach by the pump or an emetic.

(2) Give as an antidote, 15 drops of tincture of belladonna in water, and repeat the dose every quarter of an hour for four doses, or until the pulse is improved and the pupils dilated.

(3) Give stimulants freely; and maintain breathing if necessary by artificial respiration (p. 1011).

Cannabis Indica (Indian Hemp) produces a species of intoxication like opium. Later a feeling of weight in the legs and intense depression come on, and subsequently sleep and stupor. Treat as for opium poisoning (p. 1025).

Poisoning by Henbane or Hyoscyamus is attended by symptoms similar to those which follow poisoning by belladonna, to which the reader should refer (p. 1027). The root of the plant has been eaten in mistake for parsneps.

Poisoning by Datura Stramonium (Thorn-apple—Devil'sApple—Jamestown Weed).—The leaves of this plant (see Plate XII.) have been mistaken for senna leaves, and a deadly infusion made; children have died of eating the seeds.

The symptoms resemble those of belladonna poisoning, flushed face, fixed dilated pupil, indistinct vision, delirium, convulsions, paralysis, and death. One hundred seeds killed a two-year-old child. Treatment is the same as for belladonna poisoning.

Nux-vomica and Strychnine.—The powdered nux-vomica seeds and their active principle strychnine are used in the manufacture of vermin killers, such as Butler's, Battle's and Gibson's, and thus accidents arise. Thirty grains of powdered nux-vomica have proved fatal, so also have three grains of extract, while of strychnine a half grain to two grains is the fatal dose for an adult, but a child between two and three years of age was killed by a sixteenth part of a grain. In fatal cases death generally occurs within two hours. In one case death occurred in twenty minutes after the poison was taken.

Symptoms.—All preparations of nux-vomica and strychnine have an intensely and persistently bitter taste, and if the drug has been taken by accident, this bitterness will certainly strike the person. The symptoms begin within fifteen or twenty minutes of taking the drug. There is a sense of impending suffocation, restlessness and excitement, a preternatural acuteness of sight, hearing, and taste, twitchings or jerkings of the head and whole body, and then, in an instant, the whole body is seized with a violent convulsion. Every muscle is fixed and rigid, head thrown back, chest fixed, corners of mouth drawn down, and by the rigidity and contraction of muscles the whole body becomes arched backwards, in which case it rests on the back of the head and soles of the feet, like a bow, a position called **opisthotonus**. At this time, owing to the rigidity of the chest, breathing is arrested, and the face becomes bloated and dark; the eyes are prominent and the pupils dilated, but consciousness is not lost. In half a minute or a little more the muscles relax completely, and the patient lies exhausted and bathed in perspiration, the breathing becoming regular, and the lividity passing off. But soon another spasm, perhaps more violent than the first, seizes the person, following the same course, to be succeeded also by another, till death occurs from exhaustion or suffocation. The slightest thing will determine a renewal of the spasm, even a whiff of cold air upon the skin.

Treatment.—(1) Give an emetic of a table-spoonful of mustard in a tumbler of water, or 30 grains of sulphate of zinc in water, or 20 grains ipecacuanha; the stomach-pump is not available unless immediately after the poison has been taken, because of the risk of determining a convulsion.

(2) Give quantities of animal charcoal in water, or 30 grains of tannic acid in water, and a second emetic to empty the stomach.

(3) To lessen the spasms give 30 grains of chloral hydrate along with 60 grains of bromide of potassium, and every fifteen or twenty minutes give additional doses of 10 grains of chloral hydrate with 60 grains bromide of potassium so long as the tendency to spasm exists.

(4) Chloroform or ether inhalation is useful, if one is at hand used to their administration.

(5) It is necessary to keep the person warm and absolutely quiet, every noise of shutting door or sudden sound being liable to determine a convulsion.

(6) Artificial respiration may be needful.

Paraffin-oil (Petroleum, Rock-oil, Kerosene, Mineral Oil). — If such mineral oil has been swallowed, the smell of the breath and vomited matters will indicate it. Great prostration is produced, pain in throat and stomach, thirst, restlessness, and stupor.

Treatment.—(1) Use a stomach-pump, or an emetic of sulphate of zinc or ipecacuanha powder (20 grains) in water.

(2) Give stimulants freely, and keep the patient warm.

Poisoning by Vegetable and Animal Irritants.

Many vegetable substances, used in medicine, when given in excessive doses produce symptoms of poisoning by intense irritation of the stomach and bowels, vomiting, purging, pain in the abdomen, great prostration, weak pulse, moist skin, and collapse.

Such substances are:—

- Aloes,
- Castor-oil Seeds,
- Croton-oil,
- Colocynth,
- Elder Leaves and Flowers,
- Gamboge,
- Hiera-picra, a compound of aloes with canella bark,
- Podophyllum (May-apple or Mandrake).

Treatment should be directed

(1) To remove the substance by emetic of mustard (table-spoonful) in water,

(2) to quiet the stomach and bowels by warm bland drinks, white of egg and water, milk (iced), gummy water, barley-water, and by the use of warm poultices to the abdomen,

(3) to overcome the depression by brandy or whisky or aromatic spirits of ammonia, administered in tea-spoonful doses, frequently, as seems necessary.

(4) Camphor may be given, 10 drops of spirit in milk, every ten minutes, for three or four doses.

(5) If necessary, to relieve pain and stop purging, give 5 to 20 drops of laudanum in water, repeated in an hour, if needful.

Arum maculatum (Lords and Ladies, Cows and Calves, the Parson in the Pulpit, Wake-robin, Cuckoo-pint).—This is a poisonous plant, common in moist hedgerows and shady woods in England. Its bright-coloured fruit (Plate XII.) is a temptation to children. It produces severe irritation of mouth, stomach and bowels, causing swelling of the tongue, vomiting and purging. The pupils are dilated; convulsions and insensibility precede death.

Treatment.—(1) Give an emetic—20 grains sulphate of zinc or 20 grains ipecacuanha powder.

(2) Follow this with a full dose of castor-oil.

(3) Give a large cup of hot strong coffee, and stimulants as well.

(4) Keep the patient warm and relieve the bowel pain by warm poultices.

Camphor (p. 850).—The chief symptoms of camphor poisoning are nervous in character. A species of intoxication is produced, with giddiness, faintness, noises in the ears, delirium, convulsions, disturbances of vision, prostration. The pulse is quick and feeble, and the breathing difficult; and there may be pain and difficulty in making water. A piece the size of a nut has killed a child; but recovery has taken place from even nearly ½ ounce.

Treatment.—(1) Use the stomach-pump or an emetic.

(2) Give stimulants freely, preferably by injection into the bowel, as spirits given by the mouth would dissolve solid camphor in the stomach.

(3) Dash hot and cold water alternately over the head and chest.

(4) Keep the patient warm.

Cantharides (Spanish-fly) cause great irritation of mouth, throat, stomach, and bowels. There is vomiting and purging, blood being vomited and passed. The urine is bloody; there is strangury, fever, swelling of the salivary

glands, loss of sensibility, and convulsions. Death has taken place from 24 grains, but recovery after an ounce.

Treatment.—(1) Empty the stomach by a pump, or give an emetic.

(2) Follow with soothing drinks, gummy or barley water, white of egg in water, iced milk, &c.

(3) Apply hot poultices to the belly, and give 30 drops of laudanum to relieve pain.

Cocculus Indicus is the berry of *Anamirta Cocculus*, a climbing East Indian shrub. The seed, which contains the poisonous ingredient, an active principle called **picrotoxine**, is inclosed in a dark brown husk, which contains no poison. If the whole berry is swallowed, less risk of poisoning occurs from the hard husk preventing digestion of the kernel. The seeds are fraudulently added to beer to increase its intoxicating property, and the powder is used in medicine as an ointment for vermin and skin diseases.

Symptoms are sickness, vomiting, muscular weakness, intoxication and stupor, sometimes convulsions.

Treatment.—(1) Use stomach-pump or an emetic.

(2) Give charcoal in water and again excite vomiting.

(3) Give 20 grains chloral hydrate in water, to be followed if necessary in fifteen minutes by a second dose of 10 grains. Bromide of potassium in 60-grain doses may also be given.

Digitalis Poisoning is not common, though accidents arise from the use of the medicinal preparations. The symptoms are sickness with vomiting of greenish material, purging with pain in the abdomen, small irregular slow pulse, and faintness if the patient attempts to sit up. The symptoms increase in severity with larger doses, pupils being dilated and fixed, the skin pale and covered with a cold sweat, urine is suppressed, and stupor precedes death.

Treatment.—(1) Use stomach-pump or emetic of mustard, zinc sulphate, or ipecacuanha.

(2) Give as an antidote 6 drops of tincture of aconite, and repeat it in half an hour if the heart's action has improved.

(3) Give stimulants freely, whisky, brandy, aromatic spirit of ammonia, ether, hot coffee, and if they are not retained on the stomach inject them into the bowel.

(4) The person must maintain the lying position for some time after the danger is over. Any attempt to sit up would be attended by danger of fainting.

Hellebore.—There are two varieties of hellebore, the **White** or *Veratrum album*, and the **Green** or *Veratrum viride*, or **American Hellebore**, called also **Swamp Hellebore** and **Indian Poke**. All contain an active principle—**veratria**—to which the poisonous action is due. From **Sabadilla** or **Cevadilla**, the dried fruit of a Mexican plant, *Asagræa officinalis*, this veratria is usually obtained.

The symptoms are those of irritation of the digestive canal, parched mouth, burning sensation in gullet, thirst, retching, vomiting, painful purging. There are also symptoms of nervous origin, headache, faintness, palpitation, a feeling of anxiety, pupils generally dilated, weak slow pulse, laboured breathing, and perhaps convulsions.

Treatment.—(1) Use stomach-pump or emetic.

(2) Give stimulants freely, alcoholic stimulants and hot strong coffee.

(3) Maintain the warmth of the person's body and keep him lying quite flat.

Hemlock Poisoning.—Several plants may be included in this paragraph. There is the Greater, Common or Spotted Hemlock, the Water Hemlock (*Cicuta virosa*), Fool's Parsley (*Æthusa Cynapium*, Plate XI.), Hemlock Water Dropwort (*Œnanthe crocata*). Their leaves have been eaten in mistake for parsley, and the roots of the last-named for parsnep. A whistle made of the twigs of the common hemlock has been the cause of death.

The symptoms begin with excessive weakness of the legs, which causes a staggering gait; and the weakness extends until it involves the whole body. There are sickness and a burning pain in mouth and throat. The upper eyelids lose their power and droop over the eyeballs, so that, on acount of the muscular weakness and this combined, the patient lies quiet with eyes closed. The pupils are fixed and dilated. The muscular weakness, going on to paralysis, gradually extends upwards till the heart and breathing become affected, and there is inability to swallow. Death arises from failure of breathing.

Treatment.—(1) Use the stomach-pump, or an emetic of 20 grains sulphate of zinc, or the same quantity of ipecacuanha powder.

(2) Give large quantities of strong tea or coffee, decoctions of oak bark, tannic or gallic acid in 10-grain doses, to precipitate the active principle of the drug in the stomach and prevent its absorption.

(3) Give stimulants of brandy, ether, ammonia; and keep the person warm by friction, hot blankets, &c.

(4) Artificial respiration should be resorted to to maintain the breathing, and 10 drops of tincture of belladonna may be given to stimulate the breathing.

Laburnum bark, leaves, pods, flowers, and seeds are all poisonous, owing to the presence of an active principle **cytisine**. Numerous cases of poisoning in children from eating the pods and seeds have occurred.

Symptoms are those of stomach and bowel irritation, accompanied by nervous symptoms. They are sickness, vomiting, and purging, pain in the belly, straining at stool, pallor and exhaustion, great restlessness, slow feeble pulse, drowsiness, insensibility, and muscular twitchings.

Treatment.—(1) Use stomach-pump, or mustard and water emetic, or ipecacuanha wine, an ounce in water.

(2) Give hot coffee and stimulants of whisky, brandy, or ammonia.

(3) Use a douche of hot and then cold water to the head and chest.

Lobelia Inflata (Indian Tobacco).—Many deaths are attributed to the administration of the leaves of this plant by so-called "medical herbalists." Sixty grains of the powdered leaves are likely to prove fatal. It acts as an irritant upon the stomach and bowels, producing sickness and vomiting, pain and purging, and great depression. Later, it produces nervous symptoms, muscular tremors, headache, giddiness, insensibility, and convulsions.

Treatment.—(1) If vomiting has occurred, an emetic may be unnecessary; if it has not occurred, give mustard and water, or zinc sulphate (20 grains), or ipecacuanha.

(2) Give strong tea, or tannic or gallic acid in a 30-grain dose in water.

(3) Stimulants are to be freely given, and warmth to be maintained, the person being kept lying.

(4) Give 20 drops tincture of nux-vomica as a nerve stimulant.

Meadow Saffron or **Colchicum** (Autumn Crocus) acts as an irritant to the intestinal canal, acting also upon the nervous system. Its irritant properties are displayed by irritation of the throat, thirst, burning pain in the stomach, persistent vomiting and purging. Accompanying these symptoms are intense prostration, weak fast pulse, much perspiration, and muscular twitchings. One ounce of colchicum wine has thus caused death.

Treatment.—(1) Stomach-pump or emetic.

(2) Strong tea, decoction of oak bark, or 20-grain doses of tannic or gallic acid.

(3) Free use of stimulants and drinks soothing to the irritated membrane of the stomach, white of egg drink, gum-water, barley-water, &c.

Nightshade, the **Woody Nightshade** (*Bitter Sweet*, or *Solanum Dulcamara*) with purple flowers and red berries, **Black** or **Garden Nightshade** (*Solanum Nigrum*) with white flowers and black berries, and the **Potato Apple** (*Solanum Tuberosum*), are sometimes partaken of by children because of the attractive appearance of the fruit, and cause poisoning. The symptoms are those of irritation of stomach and bowels described above, along with symptoms of nerve disturbance, stupor, convulsions, delirium, dilated pupils. Treatment consists of an emetic as ordered for lobelia (see above), a purgative of castor-oil to expel any material in the bowel, and stimulants.

Privet Berries (*Ligustrum vulgare*) have also been responsible for deaths in children.

Symptoms and treatment are similar to that adopted in cases of poisoning from yew berries.

Pulsatilla (p. 893) and **Poke Berries** (*Phytolacca decandra*) belong to the same type of poisonous plants as privet berries, so far as symptoms and treatment are concerned.

Tobacco (*Nicotiana Tabacum*).—The poisonous active principle of tobacco is **nicotine**, which when pure is a very deadly poison. Cases of poisoning have occurred from using an infusion or decoction of tobacco for worms or to procure abortion. The symptoms are sickness, vomiting, great depression, and faintness, dimness of sight, weak pulse, cold clammy skin, convulsions and stupor.

Treatment.—(1) Use stomach-pump or emetic of large draughts of water, mustard (table-spoonful) in water, sulphate of zinc or ipecacuanha powder (20 grains) in water.

(2) Give strong tea, or 20 grains tannic or gallic acid.

(3) Use stimulants freely, brandy, aromatic spirit of ammonia, &c.

(4) Keep the patient warm, lying flat in bed.

(5) Give 20 drops tincture of nux-vomica in water.

Turpentine, taken by mistake or given for worms, may produce poisonous symptoms re-

sembling those of opium, namely intoxication, then insensibility with contracted pupils, weak pulse, noisy breathing, stupor and convulsions. The treatment would be draughts of mustard and water to induce vomiting, milk, egg-water, barley-water, gummy water, and one ounce of Epsom salts in water to act as a purge.

Virginia Creeper (*American Ivy, Ampelopsis quinquefolia*).—The leaves of this plant, chewed by children, have occasioned poisoning with symptoms like those produced by yew berries. Treatment is the same.

Yew Berries and Leaves (*Taxus Baccata*) are also poisonous, and deaths of children have resulted from their being eaten. A tea of the leaves is sometimes used to restore monthly illness.

Symptoms are perhaps vomiting and purging, paleness of face, coldness of extremities, small pulse, dilated pupils, insensibility, and convulsions.

Treatment.—(1) Emetic of a table-spoonful of mustard and water, or 20 grains of either sulphate of zinc or ipecacuanha powder in water, to be followed by

(2) Stimulants of brandy, whisky, or aromatic spirit of ammonia.

(3) Maintain warmth by friction, hot bottles, &c.

Poisonous Clothing, Wall-papers, Hair Dyes and Cosmetics.

Poisonous Clothing is considered on p. 732.

Poisonous Wall-papers.—See Arsenic, pp. 823.

Poisonous Hair Dyes and Cosmetics.—Hair dyes and enamelling liquids for the skin frequently contain lead, and are apt to occasion symptoms of chronic lead poisoning (p. 1022). Lotions for the complexion are sometimes poisonous because of the presence of corrosive sublimate (p. 1023).

Poisonous Food.—See Unwholesome Food (p. 597), and see pp. 646, 653 for impurities in waters. Poisonous mushrooms are considered on p. 583.

Section VII.—AMBULANCE AND STRETCHER DRILL.

Ambulance:
- *Army Ambulance Work;*
- *Ambulance for First Aid in Civil Life.*

Stretchers and Stretcher Squad Drill:
- *Formation of Company for Stretcher Drill;*
- *Formation of Stretcher Squads;*
- *Exercising Squads with Stretchers;*
- *Equipment of a Stretcher Squad.*

Ambulance.

Army Ambulance Work.—In the English army ambulance system each division of an army corps has connected with it a Divisional Ambulance Company. This consists of two bearer companies, each of which is composed of 1 surgeon-major in command, 2 surgeon-captains or surgeon-lieutenants, 1 sergeant-major, 6 staff sergeants and sergeants, 6 corporals, 47 privates, and 1 bugler, as well as the officer and men of the Army Service Corps attached for transport duties. As every army corps numbers 3 divisions, each of which, as we have said, has 2 bearer companies, and as the army corps has besides a cavalry brigade, which has 1 bearer company (a half divisional ambulance company) attached to it, and a body called the Corps Troops, of reserve artillery and engineers, which has also 1 bearer company, each army corps has thus 8 bearer companies (or 4 divisional ambulance companies). The men of a bearer company belong to the Medical Staff Corps, and have no relation to the regiments, battalions, or brigades composing a division. They are an integral part of the Medical Department of the army, which is a completely separate organization. The bearer company is subject to its surgeon-major in command, and the two bearer companies of a division, forming the divisional ambulance company, are under the command of the principal medical officer of the division, while the four divisional ambulance companies of the army corps are medically administered by a surgeon-general on the staff of the general in command of the army corps. Each bearer company has a surgery wagon, fitted with baskets containing instruments and medical and surgical appliances, cooking utensils and medical comforts for the wounded, and carries an operating table, and surgical dressing tent, for fitting up at the dressing station; it has also

A STRETCHER SQUAD MARCHING WITH LOADED STRETCHER.

This shows a stretcher squad marching with a loaded stretcher, as described on p. 1041. The man carrying the foot end of the stretcher is No. 1 Bearer, the man at the head end is No. 3. No. 4 is on the right side, and No. 2 on the left. The extra man, with the three stripes on his arm, is the Sergeant in charge.

Plate XVIIIa.

A STRETCHER SQUAD MARCHING WITH LOADED STRETCHER.

water carts and 10 ambulance transport wagons, as well as pack transport including cacolets and litters, field panniers borne by mules, &c. Further, each bearer company is disposed into 2 sections, each composed of 4 stretcher squads, each stretcher squad having a stretcher and 4 bearers, 2 to carry the stretcher, and 2 for relief, the latter two carrying surgical haversack and water-bottles. Thus in every bearer company there are 8 stretcher squads with 8 stretchers and 32 bearers under non-commissioned officers, the remaining members of the company being intended for duty at collecting and dressing stations.

When a division is on the eve of going into action, the 2 bearer companies of its divisional ambulance company form a dressing station, directly in the rear of the fighting line, but if possible out of fire. Here the operating tent is pitched and arrangements made for examining and classifying wounded and doing necessary operations and dressing, and administering food, &c., the officer-commanding and one other medical officer being in attendance. From the dressing station the ambulance transport wagons are sent forward to a position as near the fighting line as possible, where a collecting station is formed. Here the wagons are drawn up, and from this station the stretcher squads are sent forward, under one of the medical officers, on to the battle-field itself. A stretcher squad is ready to do any absolutely necessary dressing, to stop bleeding, &c., to give water or stimulant, and, as quickly as may be, places the wounded soldier on a stretcher, or otherwise assists him to the collecting station. At the collecting station the stretcher squads wait only long enough to transfer the wounded to the ambulance wagon, and return to the battle-field, never going in rear of the collecting station. The wagons then transport the wounded to the dressing station and again return to the collecting station. Such are the arrangements for giving immediate succour to the wounded.

Besides these arrangements there are others. Further in rear of the division, out of reach of the action, are the field-hospitals of the division, to which the wounded are taken from the dressing stations. Of these there are fourteen to each army corps, each fitted to receive 100 wounded. Here the slightly wounded may remain till they are able to go to the front and rejoin their regiment. These field hospitals move with the army, two or so miles in its rear, but still behind them, and planted in the line of communications between the army and its base are stationary hospitals, each capable of treating 200 wounded, while at the base itself there are general hospitals, capable of accommodating 500 each. Finally, between the base hospital and the permanent military hospitals at home are the hospital ships. All these arrangements, it will be noted, are under the control of the Medical Department of the army, the head of which is the Director-general of the Medical Staff; and, as already said, the members of the Medical Staff Corps have no connection with the regiments or brigades. But each regiment or battery or brigade has its medical officer, who goes with his regiment, and has a certain amount of drugs and dressing materials with him, sufficient to meet ordinary cases not requiring prolonged treatment. He has, to assist him, trained bearers, with stretchers and surgical haversacks, obtained from the regiment to the number of two soldiers per company. They form the Regimental Ambulance Bearers, have nothing to do with the organization of the Medical Staff Corps, and follow the regiment wherever it goes. In action they move about the battle-field, always in touch with their own corps or regiment, giving succour, and carrying wounded to the rear, where they hand them over to the men of the Medical Staff Corps.

In the volunteer army, until quite recently, there was almost no ambulance organization. Each regiment had one or more medical officers, but there was no bearer company, not even a stretcher squad. Recently this had been remedied to this extent, that most regiments have now an ambulance company of one or more stretcher squads with trained bearers. Behind the regiments, the deficiency was still greater. Now a Volunteer Medical Staff Corps is being raised in England and Scotland, but a regular organization of a bearer company under a principal medical officer for each regimental district is not yet within reach of realization.

Ambulance for First Aid in Civil Life. —In civil life accidents are frequent—on the street, on the railway, in the workshop, in the mine, at the dock; and much suffering and even loss of life are occasioned by the ignorance of those about the injured man, their inability to recognize what aid may be temporarily useful, and their awkwardness even in transporting him to some place where help may be obtained. In 1878 the St. John's Ambulance Association was founded in England to meet these conditions. Its objects were, by means of classes, open at little or no fee to the public, to teach the people how to render intelligently first aid to

injured persons pending the arrival of skilled medical assistance, and to place stretchers, ambulance wagons, and other appliances in suitable places for the ready and safe transport of injured persons to hospital. In 1882 the St. Andrew's Ambulance Association was founded in Scotland with similar objects. The centre of the former association is in London, of the latter in Glasgow, but they have branches all over the kingdom, and everywhere local committees can be got up and arrangements made for lectures on "First Aid". As a result of the work of these organizations very many persons of both sexes have received a training in "First Aid", so that were a person seriously injured in a busy thoroughfare, it is almost certain someone would be found in the neighbourhood who knew at any rate how to prevent further injury being done by kindly but uninstructed Samaritans. Many of the police of the larger towns have passed through ambulance classes, and in large public works, collieries, and so on, workmen have been trained to form an ambulance corps, while similar bodies exist in connection with the leading railways, composed of railway servants. In many industrial centres wagons are now placed, so that seriously injured persons can be safely carried to hospital. In America, in New York, Boston, and Chicago, civil ambulance arrangements are very complete. In New York the municipal district hospitals have regular wagons and a staff of surgeons and attendants always ready. The hospitals are in telephonic communication with the police stations and the leading thoroughfares, and within a few minutes of an accident a completely equipped wagon with a trained attendant can be on the spot.

The St. John's Ambulance Association, it may be mentioned, was formed in connection with the Knights of the Order of St. John of Jerusalem, one of the knightly orders of crusader days, founded to relieve the sufferings of the pilgrims to the Holy Land and crusaders. Then the Red Cross Societies, which sprang from the conference at Geneva, on 9th February, 1863, called to consider the subject of the treatment of wounded in war, exist in every European country. They are civil societies which send help to the field of war wherever it be, and whose flag with the red cross is recognized as protecting from molestation by either army.

Stretchers are contrivances on which wounded and helpless persons can be transported easily and without risk of injury from one place to another. As they are now familiar not only to the members of an army ambulance corps, but also, through the agency of ambulance classes, to a steadily increasing number of civilians, it will be well to note their construction. One of the earlier forms of stretcher was that devised by Baron Percy for the French army. It consisted of two parts, interchangeable. Each bearer carried a part, and thus any two bearers could in two or three minutes put together a stretcher and carry a wounded man from the field. Each part consisted of a pole, 8 feet long. At one end was fitted a lance head, of such a shape and so fixed that it could be detached and sheathed in a scabbard at the bearer's side. When it was fixed on the pole it provided the bearer with a weapon of a lance description, and when detached it could still be employed for attack or defence. The other end of the pole was provided with a ferule. Another portion of each bearer's equipment was a piece of canvas of the proper length for the stretcher, but only half the breadth. Along one side was a broad hem, into which the pole could be passed, along the other side of the canvas was a row of eyelet holes. When each bearer had taken off the lance-shaped point of his pole, and passed the pole along the hem of his piece of canvas, he had half a stretcher, and these two halves were laced together by a cord fastened to the sacking. The stretcher was still, however, incomplete, for if it were laid down a person lying on it would have nothing but the sacking between him and the ground. Besides, the weight of a person's body would cause the two poles to come together, unless some rigid material extended between the two poles to keep them apart. Accordingly, each bearer carried over his knapsack a broad piece of wood long enough to extend from one pole to another. Near each end of this cross-piece was a round hole through which one of the poles was passed, and each end was prolonged downwards a sufficient length to act as a foot, so that when the stretcher had been fitted with one of these at each end, the two poles were kept fully apart, the canvas was kept stretched, and when the stretcher was laid down the feet kept the canvas off the ground, and the wounded man was thus protected from wet, damp, or cold ground. Under cover, in the absence of other appliance, the stretcher could act as a hospital bed.

The present regulation stretcher of the English army is known as "Surgeon-major Faris's Stretcher", and is thus described by Surgeon-major Evatt: "It is most solidly built, and consists of two side poles of ash, brown canvas bottom, a pillow, two self-locking traverses,

which lock under the stretcher and keep it open. There are four wheels of lignum vitæ, on which the stretcher rolls into the ambulance wagon, and which act as legs when used as a camp bedstead, a use to which all army stretchers are liable. It weighs 32 pounds, and costs at the Royal Arsenal, Woolwich, about £3. To aid the bearers it has two leather slings, one at either end, which the bearers put over their neck like a milkman's yoke, and so relieve their arms of part of the weight." A strap fixed transversely near one end of each sling keeps both poles together when the stretcher is folded up.

Besides the poles on which the canvas is stretched, the requirements of a stretcher, which permit of many varieties of form, are the traverses, the cross-pieces, that is, which keep the poles apart when the stretchers are prepared for use, and the feet. In the English pattern the traverse is in two halves, one being fixed on each hole, and they are hinged at the centre, the end of one half overlapping that of the other half and hooking on to it when the traverse is straightened. The traverses are fixed near the ends of the stretcher, so that the bearer's hand passed under the end of the canvas readily grasps the traverse, and straightens it, thus separating the poles to the utmost, and fixing them. The feet also permit of many varieties of form, some as in the Faris pattern having small wheels in a fixed position, others having feet which fold up when the traverse is folded, and extended when the traverse is straightened. There is yet needed, however, a stretcher for both army work and for accidents in civil life, which besides being strong enough to fulfil all the requirements of carriage, will also be so light that one man can run with it, so arranged and made of such material that it can be folded up so as to occupy small space, so simple in construction that no mechanical knowledge is required to understand its parts, that it is not easily broken and not apt to get out of order.

Various modifications have recently been devised for use in mines and pits, where accidents are so numerous, which permit an injured man to be raised up the shaft in a comfortable position and secure from slipping.

Surgeon-major Evatt recommends, and ambulance associations all over the country are endeavouring slowly but steadily to realize it, "that stretchers should be kept in every street in our great cities, in a stretcher locker [painted red] of which the police and certain residents should have keys. Every railway-station should also have one, also every guard's van in all passenger trains. No public school, factory, institution, or asylum should be without such aid in carrying injured people. Probably many chemists would be glad to keep such stretchers in their pharmacies, and exhibit a notice to that effect in their windows, if any philanthropic society would provide the article."

Stretcher Drill.—Ambulance classes for giving to civilians training in rendering first aid to injured persons are now numerous all over the country. Part of the instruction they invariably receive is in the use of stretchers, and a modification of the stretcher drill as used in the army ambulance work is commonly employed. The writer's experience, however, is that a literal adhesion to the army drill is not attended by any difficulty, a company of boys even going through the movements with great precision and accuracy after two or three drills, and evincing real enjoyment in the occupation. The author, therefore, thinks it will be useful to ambulance societies and ambulance pupils to give that drill in detail.

The most suitable number to drill together is sixteen or twenty. That would be a sufficient number for four stretcher squads with four stretchers. Of course even only four would be sufficient to drill together as one squad, but it is well to drill two or three squads together in order to excite a healthy rivalry, and also to inculcate the necessity of all working together, not only the members of one squad working as one man, but all the squads keeping together as one man.

Formation of Company for Stretcher Drill.

The instructor takes up his position opposite the place where he wishes the right-hand man of the line to stand, and gives the command

Company—fall in.

Whereupon the men take places in succession, the man at the right-hand end of the line taking his position directly facing the instructor, and two paces in front of him, the remainder falling in one after the other in line with the first and on his left. Each man as he falls in takes up the position of attention, already fully described on p. 761, the elbows being slightly turned outwards. When all are properly in line each man should be able to feel his right or left hand man at the elbow, and to see the lower part only of the face of the second man from him on either side, by turning his eyes to one side or other, but his head being kept unmoved. The line is now

to be "sized", that is to say, the men will be caused to change their position in the line, the tallest man being placed on the extreme right, and the shortest at the left end of the line, the remainder occupying a position in the line according to their size. This is done by the following orders:—

Number.

Upon this the right-hand man calls out "one", the second man "two", and so on down the line.

The instructor will then form the company two deep in the following manner. He will first give the order,

Odd numbers one pace forward, even numbers one pace step back—march.

Whereupon numbers 1, 3, 5, 7, &c., down the line step forward one pace, numbers 2, 4, 6, 8, &c., down the line step back one pace.

The instructor next cautions No. 1 to stand fast, and commands

Ranks, right and left—turn.

With the word "turn" the front rank (the odd numbers) turns to the right, except No. 1, who still keeps facing the front; the rear rank (the even numbers) turns to the left. In this position the front rank is facing to the right, and the rear to the left.

The next order is

Form company; quick—march.

At this command No. 3, the second man of the front rank, marches up and places himself behind No. 1, and two paces (60 inches) in rear. The next front-rank man, No. 5, marches up to the left side of No. 1, where he halts and turns to the front. The next front-rank man, that is No. 7, marches up behind No. 5, and is thus in line and on the left of No. 3. Meanwhile the remaining men of the front rank are marching up, and are taking their position alternately in the front and reak ranks, as already described for Nos. 3, 5, and 7, and the rear rank is marching down behind the front rank to tail in with and follow up the last man of the front rank, and to take position, one to the front and the next to the rear, as already noted.

In marching up, the front-rank men form first one to the front, the next to the rear; but the rear-rank men form up, the first to the rear, the next to the front.

When this movement is completed the company is standing, in the position of attention, in line, two deep, and the shortest men are in the centre, and the tallest on each side of them.

The instructor then gives the order

Right—dress.

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The right-hand man of the front rank stands fast, and the others glance towards the right, without moving the head, and shuffle forwards or backwards till each man is so in line that he is able to distinguish just the lower part of the face of the second man beyond him.

It is to be noted that in stepping forward or back, the step is begun with the left foot, which is carried forward or back a distance of 30 inches, the man's body being kept all the time perfectly erect. When the left foot has touched the ground, the right is carried forward or backward to be in position of attention, heels together, toes pointing outwards, and the feet forming together an angle of 45 degrees.

Each set of two, a front-rank and a rear-rank man, forms a file, and 8 files will thus contain 16 men in two lines of eight men each.

In the event of the company consisting of an odd number, the position third from the left end of the rear rank is left blank.

The company is again numbered *in files* by the command

Company—number.

The man on the extreme right calls out "one", the man next to him (in the front rank) "two", and so on down the line, the rear-rank men not calling out at all, since the number of their corresponding front-rank men apply to them.

The company having been thus formed two deep and duly sized, each man must remember his relative position in the company, and when at the next exercise the company is ordered to fall in, each man must quickly and quietly take his post, noting that he is in the proper attitude of attention and accurately in line with his neighbour.

Formation of Stretcher Squads.

The company has been drawn up, standing in line, two deep, as already described, and the files have been numbered from the right down the line to the left, so that the first or right-hand file is No. 1, the second file (on the left of No. 1) is No. 2, and so on. This numbering must be noted in explanation of what is to follow, where we shall have to speak of the files with odd numbers as "odd files" or "right files", and the files with even numbers as even files or "left files".

The instructor gives the command

Form—fours.

On the word "fours", the left or even files, that is Nos. 2, 4, 6, 8, &c., will step back 30 inches to

the rear with their left feet, and immediately thereafter 27 inches to the right with their right feet. The result of this is that, considering for the moment only files 1 and 2, these two files form together a squad four deep, in which the front man is the front-rank man of No. 1 file, the second man is the front-rank man of No. 2 file, the third man is the rear-rank man of No. 1 file, and the fourth man is the rear-rank man of No. 2 file, and the company of 8 files is now standing in 4 squads, each four deep, separated by intervals from one another.

Each squad of four deep is called a stretcher squad, and each member of a squad is called a bearer.

In the further drill of a stretcher squad, it is necessary to give each bearer a number for purposes of identification. The bearers in the front rank are called No. 1 bearers, those in the second rank No. 2 bearers, those in the third No. 4 bearers, those in the rear rank No. 3 bearers. This is intimated to the squads by the instructor in the following words:—

Front Rank. No. 1 Bearers—stand at ease.

At the word "ease" the front rank down the line of squads takes up the "stand at ease" position, described on p. 761. Then the instructor proceeds

Second Rank. No. 2 Bearers—stand at ease.

Again on the word "ease", the second rank takes up the proper position, so the instructor proceeds

Third Rank. No. 4 Bearers—stand at ease.

Fourth Rank. No. 3 Bearers—stand at ease.

All the bearers having thus been shown what their numbers are, the instructor brings the squads to their former position by the command

Company—attention.

He may repeat this till every one knows his number as a bearer, and at once responds to his own number.

The next thing is to number each of these squads in order from the right. The instructor orders

Number—the squads;

and the front-rank man of the right-hand squad calls out "one", the front-rank man of the next squad calls out "two", and so on.

Exercising Squads with Stretchers.

Previous to the drill being begun, the stretchers are laid in a heap on the ground. The No. 3 bearers should now be marched to the heap, each No. 3 taking a stretcher for his squad. This is done by the following commands:—

Nos. 3—right (or left) turn.

All the Nos. 3 turn as ordered, right or left being ordered according to the position of the heap of stretchers. The next order is

File on stretchers—quick march.

On the word "march", the Nos. 3 step off, one behind the other, keeping step, the leading man taking the nearest way to the stretchers. When the stretchers are reached, the leading man picks up one and places it, at the slope, on his right shoulder, rollers to the front. He then marches on to give room for the other bearers to come up, each in turn, and secure a stretcher. When he has marched on sufficiently far, the instructor should give the order

Mark time in front.

When the last bearer has secured his stretcher, the instructor should order

About turn—forward;

whereupon the bearers should turn about and march back, still in file, but the bearer who was last now leading, till the squads are reached, when the bearers should march in, each to his proper place. The instructor then gives the orders

Halt. Front.

The instructor now gives the order

Lower—stretchers,

when the Nos. 3 take the stretchers from the shoulder and lay them on the ground on the right of the squad, passing what, at the slope, was the lower end to the front, rollers to the right of the squad. The next command is

Stand to—stretchers;

whereupon No. 1 sees that his toes are in line with the front end of the poles, No. 3 that his heels are in line with the rear end, No. 2 that he is one pace in rear of No. 1, and No. 4 one pace in front of No. 3, all touching the stretcher with the right foot.

The squads are next to be exercised lifting, marching with, and lowering stretchers.

On the command

Lift—stretchers,

Nos. 1 and 3 (the front and rear men) stoop down and take hold of the handles of both poles with the right hand—rollers away from them—and rise to attention together, holding the stretcher at the full extent of the arms.

In stooping, the men must keep the knees straight; the rear bearer must time his movements with those of the front-rank man, and the men of succeeding squads must time their movements with those of No. 1 squad, so that all the squads act together as one man.

On the command

Lower—stretchers,

Nos. 1 and 3 stoop down, place the stretcher on the ground and rise to attention together, again all squads acting together, taking time from No. 1.

Marching with Stretchers.

The squads are now made to lift stretchers and practise marching in close order, the following being the commands:—

Lift—stretchers.

If several squads are drilling together, they are caused to dress up in line with one another and at proper distance from one another (27 inches) by the command

Right (or left)—dress.

The No. 1 of the flank squad named (right or left) stands fast, the Nos. 1 of the other squads look to that flank and move up or back to get into line, the other bearers look straight to their front and get accurately behind the bearers in front and at proper distance. The dressing being finished, the instructor gives the order

Eyes—front,

when all look straight to the front. This being done, the instructor calls out

The Company will advance. By the right (or left), quick—march;

whereupon the squads all start off with the left foot, keeping in line with the squad named, that on the right or left as the instructor happens to order.

When the company is on the march, at the command

The Company will retire. About—turn,

the bearers of each squad will turn about towards the stretcher, Nos. 1 and 3 transferring it from the right to the left hand at the same time. When retiring the company is made to advance by the command

The Company will advance. About—turn.

The bearers turn *towards* the stretchers as in retiring.

The squads should also be practised marching in extended order, with four paces interval between each squad. The squads having been made to lift stretchers, receive the order

From the right (left, or No. — squad), to four paces—extend.

The squad named (right, or left, or No. 2, &c.) stands fast, the other squads turn to right or left, away from the named squad, and step off in quick time.

Suppose the order has been "From the *right*, to four paces—extend", then the right-hand squad—that is No. 1 squad—stands fast, the other squads turn to the left and step off. As soon as the squad next to the right—that is No. 2 squad—has taken four paces, it halts and turns to the front. The No. 1 bearer at the moment of halting taps with his left hand the shoulder of No. 1 bearer of the next squad—No. 3 squad. That squad (No. 3) takes four paces from the moment their No. 1 bearer has been tapped, and it then halts and turns to the front, their No. 1 bearer, at the moment of halting, tapping with his left hand the shoulder of the bearer in front of him, that is No. 1 bearer of No. 4 squad. So the process would go on though twenty squads were drilling together, till the whole twenty were extended in a line at four paces interval from one another.

If the order has been to extend from the left, then the left-hand squad stands fast, and the others turn to the right and step off, the first squad from the left taking four paces, then halting and turning to the front, their No. 1 bearer tapping the No. 1 bearer in front of him at the moment of halting, and so on.

Suppose four squads drilling together, and the order to be "From No. 3 to four paces—extend", then No. 3 stands fast, the others turn away from No. 3 and step off. That is, Nos. 1 and 2 squads turn *to the right* and step off, No. 2 halting as soon as four paces have been taken, their No. 1 bearer tapping, as he halts, the No. 1 bearer of the squad in front—No. 1 squad, No. 1 continuing with other four paces before halting and turning to the front, while No. 4 squad turns to the left, steps off for four paces, and then halts and fronts.

If this movement of extension is ordered while the squads are on the march, the named squad (right or left, &c.) continues to move straight on, but with a short step (21 inches), the remaining squads make a half turn to right

or left, keeping at the full pace, and, when they have reached the proper distance, turn to the front and step short. When all the squads have reached the proper interval, the full step is resumed on the command

Squads—forward.

If the squads have been extended, they may again be brought into close order. The command is

On the right (left, or No. — squad)—close.

If the squads be halted at the time, the named squad stands fast, the others turn and march towards it at quick time, halting and fronting when the proper position is reached—an interval of 27 inches between each squad.

If the squads be on the march, when the order is given, the named squad marches straight on, *stepping short*, the other squads make a *half turn* towards it and close in upon it at quick time, each squad turning to the front and stepping short, when its proper position is reached. When all the squads have closed in, the full step is resumed on the order

Squads—forward.

To Prepare Stretchers for Use.

The squads are brought into extended order (4 paces interval) as already explained. The command

Prepare—stretchers

is given. On the word "stretchers" Nos. 1 and 3 of each squad turn to the right, kneel down on the left knee, unbuckle the straps, separate the poles, pass a hand under the traverse to make sure that it is locked. The slings are then taken and doubled, dressed side of the leather out. The loop formed by the doubling is slipped on the near handle of the stretcher, and the free ends rest over the opposite handle. Both bearers then rise to the former position, Nos. 2 and 4 meanwhile standing fast. The rear bearer keeps time with the front bearer, and those of succeeding squads with No. 1 squad. The front bearer of No. 1 squad must, therefore, make certain the other bearers are ready before he rises, so that all may rise together.

On the order

Close—stretchers,

Nos. 1 and 3 turn to the right, kneel on the left knee, remove the slings from the handles and place them on the ground, place the hand under the canvas and bend inwards the traverse, raise the canvas, so that it does not catch between the poles, bring the handles together, rise, lifting the stretcher, face one another, place the handles between their thighs, rollers to the right of the company, roll the canvas tightly round the poles (towards the right of the company). Each takes a sling, passes the buckle end to the other, threads the transverse strap through the loop of the other sling and buckles tightly, close to the rackets. Grasping both handles in the right hand, back of the hand to the right, they turn to the right of the company in a slightly stooping position. From which, all being ready, they rise together and turn to the front, taking time from the right.

To repeat this exercise the company is ordered to lower stretchers, and the orders "Prepare stretchers", &c., are repeated.

Lifting and Lowering and Marching with Prepared Stretchers.

The next exercise is in lifting and lowering prepared stretchers, and in marching with them.

The order to prepare stretchers having been given and carried out as described, the command is given

Lift—stretchers.

On the word "stretchers" Nos. 1 and 3 stoop down, grasp the doubled sling, at the centre, with the finger and thumb of right hand, remove it from the handles and stand up. Each then takes a side pace to the right over the near handle, and closes heels. Each then places the sling, equally divided, over his shoulder, with the end to which the transverse strap is attached over the right shoulder. They stoop, slip the loops of the sling over the ends of the poles, commencing with the left, and then firmly grasp the poles. After a short pause they steadily raise the stretcher off the ground, and stand up, holding the stretcher at the full extent of the arms. No. 3 must keep time with No. 1, the stretcher being kept horizontal throughout. Thereafter No. 2 takes two paces to the front, and turns to the right about, thus facing No. 1; No. 4 turns to the left about (at the same instant No. 2 turns) and faces No. 3. Nos. 2 and 4 then adjust the sling on the neck and shoulders of Nos. 1 and 3 respectively, so that it lies accurately on the hollow of the shoulder in front and is well under the collar of the coat. No. 2 then takes two paces to the rear, and he and No. 4 front together. In all these movements the bearers must act together,

turning together, &c., the time being given by the No. 1 squad.

In the early practice of this exercise, these movements are timed by the instructor calling out "one", when the bearers begin the movements. When they have completed them as far as placing the sling on the neck, he calls out, "two", when they stoop and adjust the slings on the poles; and "three", when they should rise together. But after some practice, the bearers must judge the times themselves.

On the order

Lower—stretchers,

Nos. 1 and 3 lower the stretcher to the ground, slip the loops off the handles, stand up, remove the sling from the shoulders, double and hold it in right hand between fingers and thumb, then resume the original position at the side of the stretcher by taking a pace to the left over the handle, stoop down, arrange the sling on the handles as already described, and rise together.

The stretchers having been prepared as described, and lifted, the squads are to be practised marching with them.

On the order

By the centre—advance,

Nos. 1 and 3 step off immediately, No. 1 with the left foot, No. 3 with the right, *so that the step is broken,* and no side-to-side movement communicated to the stretcher. Meanwhile No. 4 turns outwards (to the left), moves smartly round the rear bearer, and up to the centre of the opposite side of the stretcher, while No. 2 marks time one pace, and is thus opposite the centre of his side of the stretcher. Nos. 2 and 4 keep step with No. 1.

It is very important to see that the bearers so march with prepared stretchers that no jolting would be suffered by a wounded man borne by them on the stretcher. This is best secured by them taking a short step of 20 inches, the knees well bent, the feet being raised little off the ground, the step being broken, as already noted, and the stretcher being kept horizontal.

On the order

By the centre—retire

with prepared stretchers (or on the order "Advance", when the squad is retiring) the squad will wheel by the right to the rear (or front), No. 3 simply marking time, and slowly turning till the wheel is accomplished.

On the order "Halt" Nos. 2 and 4 resume their old positions, No. 2 taking one pace to the front, and No. 4 turning outwards and doubling round the head of the stretcher to his old place on the left of the stretcher.

To Load or Unload Stretchers.

To practise loading and unloading stretchers, men to represent wounded are caused to lie down, the head towards the company, ten paces in front of the company and extended four paces from one another. The squads, standing in close order with stretchers lifted but closed, receive the order

Take post at the right of wounded—advance.

Each squad moves to its patient and halts without further command two paces on the side indicated and in line with him. The following commands are then given:—

Lower—stretchers,
Prepare—stretchers,

and acted on as already described.

The next order is

For loading, lift—wounded.

Nos. 1, 2, and 3 wheel round by the patient's feet, and march up on his left side (No. 3 passing by the left of No. 4), No. 1 halting opposite his shoulders, No. 2 opposite the hips, and No. 3 opposite the knees. They turn towards him together, No. 4 then placing himself opposite No. 2, that is next the patient's hips. All kneel on the left knee. No. 1 passes his right arm beneath the patient's right shoulder and his left across the patient's body, his left hand being passed under the patient's right shoulder. Nos. 2, 4, and 3 pass their arms, close together, under the patient's loins, hips and knees respectively. If the patient is able, he places his arms round the neck of No. 1 bearer, clasping his hands. The bearers, as one man, slowly lift the patient 24 inches off the ground, resting him on their right knee. No. 4 relinquishes his hold, doubles round by the head of the stretcher to the centre of the opposite side, grasps the near pole with his left hand and the farther one by his right, lifts the stretcher and places it directly under the patient. He then kneels and helps to support the patient.

The instructor now gives the command

Lower—wounded.

The bearers gently lower the patient on to the stretcher, remove their hands from under him, special care being taken of any wounded part. They then stand up, and resume their former

position in line on the left of the stretcher. To do this Nos. 1, 2, and 3 turn to the right, and wheel by the right to their places, No. 1 at and to the left of the patient's feet, No. 2 behind him, &c., No. 4 meanwhile turning to the left, and wheeling round the head of the stretcher by the left of No. 3 to his place behind No. 2.

The order is then given

Lift—stretchers,

and is carried out in the manner already described for unloaded stretchers. The squads are to be practised advancing and retiring with loaded stretchers, as they did with unloaded stretchers, the bearers marching with short broken steps to prevent jolting and injury to the patient, as already directed. This is made easier if the bearers are as nearly as possible of equal height. On sloping ground the general rule for bearers is to carry the foot end of the stretcher foremost down hill, and the head end foremost up hill. On halting and lowering stretchers, the bearers must take great care to prevent jolting.

The squads having been halted and the stretchers lowered, the command to unload the stretcher is given thus:

For unloading—lift wounded.

No. 4 turning outwards (to the left) doubles round the head of the stretcher to the centre of the opposite side, and the whole turn to the patient together, No. 1 placing himself opposite the knees, No. 2 opposite the hips, and No. 3 opposite the shoulders of the patient. They then proceed to lift the patient to their knees, as already directed. No. 4 grasps the stretcher, as before described, steps back two paces, places it on the ground, doubles back to his place round the head of the stretcher, and resumes the support of the patient.

The instructor then orders

Lower—wounded.

The patient is lowered, the bearers disengage and stand up, resuming their proper places at the left of the stretcher as follows:—All turn to the left, Nos. 1, 2, and 3 wheel by the left round the head of the patient to their places, No. 1 at the foot and to the left of the stretcher, &c., No. 4 falling in between Nos. 2 and 3.

The completion of the exercise is effected by the following commands:—

Close—stretchers.
On the right—close.
Lower—stretchers.
About—turn.

On the last order the bearers turn about, and on the further order

By the right—quick march,

they march off, leaving the stretchers on the ground.

When they have marched clear of the stretchers, they are ordered to halt, and immediately after the order is given

Front.

Whereupon the bearers, at the moment standing four deep facing the rear, turn together to the front and immediately form up two deep, by the Nos. 2 and 3 of each squad taking a pace of 27 inches to the left with the left foot, and a pace of 30 inches to the front with the right foot. This brings them into the formation described on p. 1036, before the formation of fours.

The next commands are

Right—dress (see p. 1036); **Right—turn,**

when the men will turn as directed. Finally on the order

Dis—miss,

the front rank will take a side pace to the left, and the rear rank will take a side pace to the right. After a pause the company will break off quietly.

Equipment of a Stretcher Squad.

Besides a stretcher, each squad should be provided with a water-bottle, and a haversack containing splints, bandages, a tourniquet, scissors, and safety-pins.

No. 2 bearer carries the water-bottle; No. 4 carries the haversack. The water-bottle hangs on the left hip, sling over the right shoulder, the haversack hangs on the opposite side.

A CHAPTER ON SICK-NURSING. MEDICAL AND SURGICAL APPLIANCES.

The Duties of a Sick-Nurse.

The Qualifications of a Sick-Nurse:
The Dress of the Nurse.

The Sick-Room:
Its Cleanliness; Its Ventilation; Its Warmth.

The Sick-Bed:
Changing Sheets, &c.

The Sick Person:
The Diet—**Its Frequency, Quantity, and Method of Administration;**
The Administration of Medicines;
Clothing—**Changing Clothing;**
Discharges—**Bed-pans;**
Bed-sores.

Medical and Surgical Appliances:
Syringes, Inhalers, Nasal Douche, Catheter.
Fomentations and Poultices.
Leeches and their Application.

A Few Recipes for Sick-room Cookery.

The Duties of a Sick-Nurse.—It is an old notion that any woman who has reached, or perhaps still better, has passed, the prime of life, who has borne a large family, whether she has reared them well or not does not matter, who "has seen a lot of trouble," who has witnessed numerous death-beds, is very well qualified to be a nurse. She is "a woman of experience," and this kind of experience enables her, it is supposed, to act with authority and judgment in the sick-room, whatever be the nature of the disease the patient is suffering from, and whatever may be the emergency that arises. There never was a greater mistake than this; there is none more productive of evil to the patient. It is the same mistake which causes people to speak of the duties of the nurse, in contradistinction to the duties of the doctor! In the care and treatment of the sick the view, on which this mistake is based, supposes that the doctor has one well-defined limit of duty, and the nurse another, and the doctor must not trench on the nurse's province, lest he offend her. A nurse who takes up such a view makes a fatal mistake. She must begin her work with the idea firmly implanted in her mind that she is only the instrument by whom the doctor gets his instructions carried out; she occupies no independent position in the treatment of the sick person.

It is the doctor's business, and his only, having carefully inquired about all the facts relating to his patient's case, having thoroughly examined his condition, observed and considered all the symptoms, and having come to a conclusion as to the nature, and, if possible, cause of his illness, it is the doctor's business then to determine not only what medicines, if any, he will order for the sick person, but also what are the conditions under which the patient ought to be placed to enable him to wrestle with the disease under the circumstances most favourable for his recovery. He is bound to consider, that is to say, not only what medicines he will order, but also what food and drink are most appropriate for his situation, what kind of atmosphere he ought to breathe, what degree of heat that atmosphere should have, and every other circumstance that will aid his natural tendency to recovery. It is his business also to consider whether the surroundings of the patient are the best possible to conduce to this end, and if not, how they may be improved, so far as improvement is within the patient's power. Having arrived at his conclusions, it is then his duty to give his instructions to the nurse, to prescribe the medicines, to indicate the nature, amount, and frequence of the diet, how the patient is to be placed and covered in bed, to indicate how the apartment is to be kept as regards air and heat and light, and so on. It is the nurse's business carefully and accurately to note these instructions, not in a mere general way, but in every minute detail, to make certain that she understands the instructions given, and having received them, strictly but intelligently to act upon them and carry them out to the letter.

This is very different from the old notion that it was the doctor's business to come in, examine the patient, write a prescription, and walk off, leaving everything else to the nurse, as her business.

The first thing that is implied in this explan-

THE ARRANGEMENT OF THE SICK-BED.

THE ARRANGEMENT OF THE SICK-BED.

I. The bed is made in the ordinary way. Across the centre of the bed, thus made, is laid a waterproof sheet, and above that is laid the draw-sheet, an ordinary sheet folded once. One end of this draw-sheet is pinned down as shown in the illustration, and this leaves a long end at the other side of the bed, which is folded up to obviate soiling. When the part of the sheet under the patient has become soiled, a fresh piece can be substituted by drawing the sheet through from the short side.

II. To change the draw-sheet when the patient cannot be moved from bed, the pins fixing it are undone; to one side a fresh draw-sheet is pinned; and then one nurse, by slipping her hands under the patient's body, eases up the patient sufficiently to permit the nurse on the other side to draw through the soiled draw-sheet, which, of course, drags after it the fresh sheet attached to it.

I. The bed-clothes folded over to show the draw-sheet pinned down on the top of the ordinary sheet.

II. The draw-sheet being changed.

ation of a nurse's duties is that she, as a nurse, has no responsibility whatever beyond the responsibility of carrying out her instructions. In the treatment of a sick person there can be no divided responsibility; if there is, so much the worse for the patient. The whole and undivided responsibility of directing the treatment belongs to the doctor, the nurse is responsible only for executing the directions, not in any degree for their nature or their results. This ought to be considered by her as a great relief, a great guarantee of security, provided always, and only, that she conforms to her instructions. The second thing implied in this explanation of a nurse's duties is that she, as a nurse, has no "opinions," no "thoughts." It is not an uncommon thing for a patient, or a patient's friends to say, "What is your opinion, nurse?" If she is a well-trained nurse she will, in effect, reply, "I have no opinions on the subject;" and she cannot more thoroughly demonstrate her want of qualification and suitability for the work she has undertaken than by launching into a long account of her experience when attending Mr. So-and-so, or of what happened in an exactly similar case she had, &c. It is also not an uncommon thing for a doctor, asking an explanation of some order being left undone, to be told that it was just about to be done, when, on account of something else "nurse thought," &c. The nurse must have no opinions and no thoughts, we repeat. If it is impossible for her not to think, and impossible for her not to draw conclusions from her thoughts, she must, at any rate, keep them securely locked up in a remote corner of her mind, where they will not interfere with her execution of the orders she has received. The general in command of an army confronting the enemy moves his troops in accordance with a plan of action in his mind. He orders his officers to move their battalions in accordance with his plan, and the duty of his officers is to obey the orders they receive. If every or any captain thinks he is entitled to carry out the order he has received only so far as he deems fit, or to alter it to what he thinks better, the plan of action will be upset and the battle may be lost. So the doctor, in his fight with disease and death, marshals his forces of medicines, food, drink, and so on, in accordance with a plan in his own mind, and if the nurse whose duty it is to carry out his instructions, thinks she is entitled to modify them or set them aside, the odds against the patient are all the heavier.

A second part of a nurse's duty is to observe. In many cases of disease various changes occur within twenty-four hours, the knowledge of which would be of great value to the attending physician, and which it is impossible for him to acquire by the daily visit or by the morning and evening visit. For instance, at one period of the day there may be an undoubted rise in the heat of the body. This may recur at or about the same hour every day, but there may be no evidence of it whatever at the usual hour of the doctor's visit. It is quite clear that if this were noted by the nurse and reported to the doctor, it would be a fact of much value. Or there may be spasmodic attacks of discomfort, or pain, or breathlessness, and so on. All such circumstances it is the duty of the nurse to observe and report. But she must beware of reporting anything but the bare facts. She is apt to have her own explanation of the facts she has observed, and to colour her report in accordance with her own idea of their meaning. It is necessary, therefore, for her to train her powers of exact observation, and to exercise herself in the task of reporting exactly what occurs without alteration or addition.

What, then, are the chief points a nurse has to include in her report to the doctor at his visit? She will have to inform him (1) as to the food and drink the patient has taken, since his last visit. This she must be prepared to detail as to its actual amount, and times of administration, as well as its nature. Thus her answer should run something like this: "At mid-day yesterday he had a breakfast-cupful of beef-tea and a quarter of slice of toast. At 2 afternoon another breakfast-cupful of beef-tea and half a slice of toast; at 4 half a tumbler of milk; at 8 —," and so on. And then she should be ready to sum the whole up in some such way as this: "In all, since yesterday at 12, he has had 4 pints of milk, $\frac{3}{4}$ pint of beef-tea, 1 egg, 2 slices of bread, and 4 biscuits." The doctor would then, it is evident, have a clear idea as to whether sufficient nourishment were being given or not.

(2) The second part of the nurse's report should be as to her administration of medicine, the amount given, the hours at which it was given.

(3) The nurse should be ready to state *exactly* —in hours and minutes—what sleep the patient has had, and whether the sleep was quiet and sound, or light, or troubled and restless, and so on.

(4) The nurse ought to be ready to inform the doctor as to the emptying of the bladder

and bowels, how frequently and at what hours these acts were performed. She should have noted in relation to the urine, the quantity and colour, and in relation to the motions their size, colour, consistence, whether formed or semi-liquid, whether uniform in appearance or mottled with patches of white, &c.

(5) The nurse should have observed and noted any other circumstances that may have occurred, such as sweating, coughing, spit, vomiting, delirium or wandering, excessive thirst, headache, or any other pain complained of. As regards cough and spit, she should be ready to state the time of their occurrence and recurrence, and should have preserved in a covered mug some of the spit for the doctor's inspection. As regards the vomiting she ought to be able to state when it occurred, how it was related in point of time to the giving of food or medicine, what it was like, and should have preserved some, *but not in the sick room*, for the physician's inspection.

A nurse cannot be expected to carry all these things in her memory, and therefore they should be noted down in writing. All this will be best done by the nurse, before assuming duty, providing herself with a note-book, not a tiny penny diary, but a sensible note-book, say about 7 inches long by 4½ broad, by ½ thick. She should rule a straight line down the outer edge on one side, giving a space sufficiently broad for marking the time, and a second broader space on the inner side for "Remarks." One page may stand for a day of 24 hours, or if the case makes frequent notes necessary, one page may note the occurrences from say 9 A.M. to 9 P.M., and the following page from 9 P.M. to 9 A.M. Then down the page are entered the facts as to food, medicine, &c., the hour being stated in the narrow outer column. At the head of each page the date would be entered. The doctor would likely enough take advantage of such a note-book to record the results of his observation of temperature, pulse, and breathing. Thus in the note-book one would have almost a history of the case and always an accurate record of its progress. One page of such a note-book would have something like the following appearance:—

MARCH 10th.		REMARKS.
9 a.m.	Small dessert-plateful of porridge and a tumblerful of milk.	
10 ,,	One tea-spoonful of medicine given.	
10.30 ,,	Two wine-glassfuls of milk and soda.	
11 ,,		Patient asleep from now till 11.45.
12 noon.	Tea-cupful of beef-tea, ½ slice toast.	
12.15 p.m.	Temperature 103° / Pulse .... 118 / Breathing ... 24	Dr. called. Medicine to be given every 2 hours till further orders.
12.30 ,,	One tea-spoonful of medicine.	
1 ,,		Water passed, about ½ pint—very high coloured.
2 ,,	Tea-cupful beef-tea, ½ slice toast.	
2.30 ,,	One tea-spoonful of medicine.	
3.45 ,,		Patient slept from 2.45 till now; quiet deep sleep.
4 ,,	Half a tumbler of milk and two wine-glassfuls soda-water.	
4.30 ,,	Tea-spoonful of medicine.	
6.30 ,,	Tea-spoonful of medicine.	Profuse sweating for ½ hour.
7 ,,	Tumbler boiling milk, one slice toast.	Clothes changed.
8 ,,		Bowels moved freely—natural.
8.30 ,,	Tea-spoonful medicine.	
9 ,,	Half tumbler of milk and soda.	

It may be, and very often is, necessary for the nurse to prepare as well as administer the food of the patient. At anyrate she should be ready for such a circumstance if it arises. Therefore she should be able to cook, to prepare little dishes plainly but palatably; and she should take pains to acquire a knowledge of a variety of ways of cooking the same thing, so that she may tempt a patient's appetite or excite it. The sick man's stomach rebels against a diet from day to day everlastingly the same. And besides ministering to the feeble appetite by a dainty morsel of one kind or another, the nurse may coax a patient to try what she has prepared, by the cleanness and neatness with which it is set before him.

The Qualifications of a Sick-Nurse.—If such as have been stated are the duties of a sick-nurse, it will not after all be an easy task to fulfil them thoroughly. The qualifications for the post will be manifest. Intelligent, painstaking, careful, exact, methodical, all these are very necessary qualities in the nurse. She must be scrupulously clean and tidy in all her ways. If so the sick-room will be clean and orderly, so also will the sick-bed be. In her person she will also be clean and neat. One thing is very important. Her breath must not be foul-

smelling; and to ensure this she will do well regularly to use tooth-powder and mouth-wash (see recipes No. 85 and 81). Besides all this many other qualities are needed, pleasant manners, deftness and gentleness of touch, patience, quietness of manner, &c. All her work must be done without fuss or noise, and without the manner that is perpetually drawing attention to all she is doing. One thing a nurse must not be —a gossiper or chatterer. She may beguile a little time talking if the patient desire it, but it must not be with tales of her experiences, and accounts of the sick-beds of others, their sufferings and doings. His own symptoms and ailments and prospects are not to be referred to at all. Any information he desires on these points must be supplied by the doctor.

The Nurse's Dress and Behaviour.—It has been already said that the nurse should herself be scrupulously clean and tidy. Her dress should be of soft material that will not rustle, of a quiet colour, not black. It should be of material that will wash. A white apron with bib, a pair of close-fitting linen cuffs, and a white cap are also usual and desirable. She should wear soft slippers that make no noise as she moves. She should go about the sick-room quietly but with a decided step, not shaking the floor with her movements, but equally not sneaking about on tiptoe. She should speak in her natural voice, but quietly. Whispering is not permitted in a sick-room. A whispered conversation carried on outside his half-open door is to a patient particularly exasperating. All her own dressing the nurse should do outside of the sick-room. Her meals also should all be taken outside in some other room. When she is occupied about the patient her hands should be warm but dry. A cold hand, or a moist clammy hand, is an abomination. She can warm her hands with hot water, thoroughly drying them thereafter. If she is sitting in the sick-room, she will occupy herself with some light work or otherwise. But she must take care not to be unconsciously an annoyance. Sick people are so irritable, that the smallest thing is sufficient to disturb them. The rustle of a newspaper, or turning over the leaves of a book, the monotonous click of knitting-needles, the swing of a rocking-chair, or creaking of a wicker chair, all these may be seriously disturbing.

The Sick-room.—The sick-room should be, if possible, large, especially ought it to be so if the case is likely to be a prolonged one. It is a practical impossibility to ventilate without draughts a small room, and nothing is of greater consequence in the proper tending of the sick than the maintenance of a *constantly* pure atmosphere. All excess of furniture should be removed, as it simply takes up air-space. While it is well for the pleasure of the patient to have the room as bright and tidy as possible, it is undesirable to have much of the nature of ornaments and hangings, since they harbour dust. The wash-stand should be kept constantly clean and free from accumulations of glasses, cups, bottles, and all the odd etcetera of a sick-room with which it is usually littered. A small table should stand by the bedside, within easy reach of the patient's hand. The most it should ever hold should be a glass with a few flowers, perfectly fresh, a tumbler with drinking water, perfectly clean, and very frequently renewed, and, it may be, a small tumbler containing milk and soda or milk and ice. If ice is allowed the patient, the glass of drinking water may be replaced by a tumbler, covered with a piece of new well-washed flannel containing small pieces of ice, as shown on Plate XIX., fig. 7. If any orange or other fruit is allowed, a few small portions ought to be prepared, set on a plate which is supported on a bowl containing some pieces of ice to keep it cool. No food should be prepared or cooking done in the sick-room. All ought to be prepared outside, brought in when required, and the remains with the soiled dishes ought to be removed again from the room as soon as the patient has been satisfied. In the same way all soiled linen, towels, handkerchiefs, &c., should be removed from the room without delay and should be at once immersed in water.

No slop water should be retained in the room, nor slop-pail; all should be immediately removed, the vessels washed outside and brought back clean. It is never desirable that a sick-room should contain a set-in basin, connected with the drainage pipes. If such exists in the room, and another room is not to be had, strict orders must be given to prevent its being used. The waste-plug should be set in and the basin kept full of water, frequently run off and renewed. Basins which have no drain connection, but are provided with a tank underneath, are, in some respects, still worse. They invariably give out a very unpleasant smell. If the whole stand cannot easily be removed, the tank ought to be, and some deodorizer (p. 395) used for the stand.

The Ventilation of the Sick-room is more important than almost anything else. It is quite customary for ventilation to be effected

once or twice a day by covering the patient wholly up, the head being covered as well, and then opening the windows for a few minutes till the air of the room has been completely renewed. This is all very well occasionally, but it cannot take the place of a constant renewal, which is necessary if the patient is to breathe a comparatively pure air. It is an absolute necessity that, since the air is being polluted every instant, fresh air should every instant be entering. This is ensured if a fire be burning in the grate. Therefore, one of the first things to be done in preparing a sick-room is to remove any ornaments in the grate, to open the damper, and to light a fire: if it be warm weather, the fire will of course be a small one. This fire will cause a constant current up the chimney and a constant stream through the room. The question is, whence is the air to come to supply this current? If the door and windows are kept close, it will create currents through every crack and crevice in door and window, and much of the common air from the house will be drawn through the room. If a way be opened for fresh air, however, it will be drawn less readily from other quarters. It will almost invariably be found best to draw down the window farthest from the bed, from the top, about $\frac{1}{2}$, or even only $\frac{1}{4}$ of an inch, or 1 inch by day and $\frac{1}{4}$ inch by night. The bed can usually be so placed that it will not be struck by any current of cold air, and the atmosphere of the room will be kept pure. A screen can, if necessary, always be arranged to ward off any such current from the bed. Instead of this the fitting in of a board to close the opening left by raising the lower sash for a few inches, as mentioned on p. 694, may be employed. If the need of continually renewing the fresh air of a room be kept in mind there will be little need of burning pastilles or sprinkling perfume, *which, it must not be forgotten, may hide a bad smell but will never purify the atmosphere.*

The Warmth of the Sick-room should be maintained regularly at the same degree. This degree ought to be accurately estimated by a thermometer, kept hanging so as to be out of reach of direct heat from the sun or from the fire. Avoid hanging it on a wall kept warm by a fireplace in it. It may be a blank wall on the sick-room side, but a fireplace may exist on the other side. The usual height at which the mercury should stand is 65°—never above 70° nor below 60°. The nurse should, however, ask the instruction of the doctor as to the exact degree. A nurse must remember that if she is ordered to keep the room warmer that does not imply that she is at once to block up all means of entrance to fresh air. It may mean the use of larger fires, but while she seeks to get a warmer atmosphere, she must take care it does not at the same time become a more impure atmosphere. Nor yet must she think that if the atmosphere of a room is cold it is necessarily also pure.

Sunlight in a sick-room is always desirable, unless special circumstances require darkness. But the common supposition that a sick-room should be a darkened room is a mistake. Sunlight is one of the best of disinfectants. Let the bed, however, be so arranged that the light does not fall directly on the patient's face, either by the use of a screen or by turning the bed.

The Cleaning of the Room should be done systematically, all the more regularly in that while the patient is in it it can never be done thoroughly. It must be done so that the patient is not disturbed, and so that dust is not raised. Screen the bed if possible while it is being done; dust the furniture with a cloth slightly damp; carry rugs outside and hang them up in the outer air for a little; remove as much as possible from the carpet by using a large cloth rung tightly out of water. This is to be passed over the whole carpet, the part under the bed included.

The Sick-bed.—There are two things to be noted in considering the position of the bed. The first is its position in reference to any possible draughts from doors or windows. Given a room with one door, one window, and a fire burning in the grate, it is quite clear that a current of cold air will set in from the window to the grate, and one also from the door to the grate. It is wonderful how often the bed is so placed as to be simply swept across by one or other of these currents. Commonly this can be avoided. At the worst a screen can be arranged to guard the bed on one side. Let the screen be a high one. It may be improvised of a clothes-horse and sheets or blankets. In such a case let the sheets reach quite down to and rest on the ground. Another point to observe is that one fold of the screen ought to pass right in behind the head of the bed. Usually the screen is simply stretched out along one side of the bed, and there is a space between the end of the screen and the head of the bed. The cold-air current will simply pour through this gap on to the upper part of the patient's body. The second thing to be noted in the determina-

CHANGING THE UNDER SHEET IN THE CASE OF A HELPLESS PATIENT.

CHANGING THE UNDER SHEET IN THE CASE OF A HELPLESS PATIENT.

I. The patient has been turned over on the right side, the draw-sheet has been lifted on one side, and, with the waterproof under it, is being held up over the patient. At the same time it holds and protects the patient. The soiled sheet is then rolled up lengthways as far under the patient's body as possible. A fresh sheet, previously aired and warmed and rolled up lengthways to the extent of one-half, is now laid down and properly adjusted on the part of the bed from which the soiled sheet has been removed, the rolled part of both soiled and clean sheets lying alongside one another. The waterproof and draw-sheet are now pinned down over them.

II. The patient is now turned over on the left side, the draw-sheet and waterproof lifted. The patient is thus caused to turn over the rolls. The soiled sheet is removed, the roll of the fresh one unrolled and properly smoothed out, and the waterproof and draw-sheet again pinned down. Thus a clean sheet has been substituted for a soiled one.

18c.

CHANGING THE UNDER SHEET IN THE CASE OF A HELPLESS PATIENT.

Plate XVIIIc.

I. The soiled sheet is rolled up lengthways close up to the patient, and the clean sheet, half of it also rolled up, placed alongside the soiled one.

II. The patient has been turned over on the other side, so that now the rolls of both soiled and clean sheets can be brought through from under.

tion of the position of the bed is the situation of the window. The patient should not be lying so as to face the window, if possible. It is always preferable that the bed should stand out a little way from the wall so that the nurse may easily get round it; and the fewer hangings there are about it the better. Valances prevent free circulation of air beneath the bed, and should be removed.

For any prolonged illness the bedding should be as follows: A hair mattress, protected on the top with a large square of india-rubber cloth. Above this is the under sheet. Then comes a folded sheet, spread across the bed so as to be under the patient. This is easily withdrawn when soiled without disturbing the under sheet and a clean one substituted. When there are discharges passed in bed the under sheet should be further protected by a layer of india-rubber cloth in the fold of the draw-sheet. Above the patient is a sheet, then the blankets, and then a covering of a clean sheet or other similar covering, but nothing heavy or cumbrous.

To Change the Sheets without Disturbing the Patient.—The upper sheet may be changed without folding down the clothes in the following way: The sheet having been warmed and aired (note: but not in the sick-room) roll it up in its breadth, then pass it across the bed at the foot under the sheet to be changed. Move it up over the patient, unrolling it as it goes till it is well up the bed. Then draw down the soiled sheet to the foot of the bed, and readjust the clothes. To renew the under sheet: Loose the soiled under sheet down the whole length of one side of the bed and fold it in a series of narrow plaits running lengthways close down by the patient's side. Take the fresh sheet, aired and warmed, and fold one-half of it in a series of plaits down its whole length. Lay the plaits of the clean sheet on the bed down the patient's side, alongside of the corresponding plaits of the soiled sheet. Push them up close to the patient, and gradually push them with the fingers under the patient's body, pressing down the mattress to allow them to pass. In this way the folds of the clean sheet are pushed under the patient and those of the soiled sheet *out from under* at the same time. Get the sheets pushed through under head, shoulders, and hips first, and then it is easy to raise the legs. Go round then to the other side of the bed, remove the soiled sheet, and spread out the clean one.

The pillows should be turned and smoothed frequently, and changed occasionally, and the patient should be helped to turn himself as a change. If he is sunk down in bed, the nurse assists him up on to the pillows again by bending over him, getting him to clasp his hands over her shoulders, while with her arms under his shoulders she assists him up the few inches that are necessary.

The Sick Person should wear an under-shirt of merino, and over that the usual night-gown. Only in the case of very delicate persons and children is a flannel gown necessary. It is always well to have two sets of clothing, one for night wear and one for day wear. The garments when taken off should be well aired in another room, and warmed when about to be put on again. The clothing may be regularly changed without raising the person in bed. The clothing to be put on, being well aired and warmed, is brought ready to hand. The person's arms are then slipped out of the sleeves of those he has on, which are removed by the feet while the fresh garments are put on over the head, and then the arms put in. If the case is likely to be a prolonged one it is well to have the clothing fastening down the front by tapes. The patient's hands and face should be sponged and the hair arranged now and again throughout the day; and the whole body may be sponged occasionally, as the doctor permits. This may be done under the bed-clothes just before removing the night garments. After the arms have been removed from the sleeves the nurse passes her hand under the clothes with a sponge well wrung out of soapy water, following with a towel. The whole body need not be done at a time, but bit by bit to avoid fatigue. It is well to guard the bed by a folded sheet with some rubber cloth in the sheet, pushed under the patient, while this is being done.

When it becomes necessary thoroughly to change the bed, and the patient cannot assist at all in the change, it is necessary either to move him to another bed pushed alongside the former one, and well aired and warmed for occupancy, or to place him for a time on a couch while his bed is being aired. To do this the assistance of three or four people is necessary. One stands at each corner of the under sheet, and the patient is lifted on this sheet, being kept covered all the time. He is then transferred to the fresh bed, and the fresh bed-clothes are rolled up in their breadth and introduced under the old ones in a roll at the feet, and gradually unrolled up over the patient. The soiled under sheet is then folded into plaits

down the whole length on one side, and gradually pushed out beneath the patient's body and removed. If another bed is not to be had, the couch is prepared and the patient lifted to it on the under sheet. The bed-clothes, mattress, &c., are then removed to another room, and there well aired near an open window. Thereafter, after being well warmed, the mattress is restored, fresh bed-clothes having been meanwhile aired and warmed are placed on the bed, and the patient is replaced, the soiled under sheet being then removed from under him.

The diet of the sick person, as regards its nature, amount, and frequence of administration, will have been prescribed by the physician. It is well, however, always to remember that where there is any difficulty getting the patient to take much food at a time, or to take it at all, an ample supply may yet be given by the frequent administration of very small quantities. A patient who cannot be persuaded to take, say, a cupful of beef-tea, even at three hours' intervals, may yet be persuaded to take half a wineglassful every half-hour. In a very large number of cases, vomiting may be overcome by the frequent administration of very small quantities. It is very often quite useless to bring a patient any quantity of food; and any nurse who gave the doctor as a sufficient reason for the patient having taken no food, that she brought it to him but he would not take it, simply declares her own want of tact and patience and management. A nurse should never ask a patient "Will you take a little food now?" "What shall I bring you?" "If I bring you a small plate of soup will you take it?" and so on. She should study her patient; prepare quietly a small quantity of what seems proper under the circumstances; and then, bringing it to him, should be able with a little firm but gentle management to make him take it. Children are more difficult to manage, but if the nurse is of the right kind, and can exercise, without force or anger, a little gentle authority, the probability is that in a short time she will be able to get the little patient to take food in a perfectly satisfactory manner.

In Plate XIX., fig. 10, is shown a simple arrangement for enabling a sick person to drink from a tumbler placed on a table beside the bed without the tumbler being moved. The india-rubber tube should be considerably longer than is indicated in the figure.

As to the giving of medicines little need be said except in the way of urging exactness in following the doctor's directions, and in measuring out the quantity ordered. The quantity should always be measured in a graduated glass, such as shown in Plate XIX., fig. 8. The figures *c* and *d* are very useful for doses measured by drops. The india-rubber cap is compressed between finger and thumb, the end is inserted into the bottle, and by releasing the pressure the medicine is drawn up into the tube; by gentle pressure the medicine is then forced out drop by drop.

Discharges and Bed-pans.—Whenever there is any risk of discharges being passed in bed, a draw-sheet with an ample piece of india-rubber in the fold should be under the patient to protect the bed, and no soiled sheet should be allowed to remain in the bed. Plate XIX. shows two forms of urinals for use in the bed; and bed-pans are a necessity. They should be warmed before use by being dipped into warm water; they should then be well dried, and the edge protected by a towel. When it is introduced the patient's knees should be well bent. After use the bed-pan should be immediately removed from the room, and after being well washed should be deprived of all smell by being washed in the acid solution noted on p. 396.

Bed-sores are the result of long-continued pressure on any part of the body, and they are specially apt to occur in persons of low vitality or in parts of the body where the nutritive processes are depressed owing to paralysis or other causes. Whenever long confinement to bed is necessary they must be carefully guarded against. In cases where, owing to the nature of the illness, the patient's susceptibilities are blunted, their occurrence must be anticipated, and regular examination of the body must be made to detect the slightest signs of their appearance. The places where they occur most frequently are those places which are subjected to the greatest degree of pressure—the heels, the lower part of the back, the prominence of the hip, the buttocks, and even the elbows. If the bed is not kept smooth, if folds are permitted to form under the patient, and specially if the skin is allowed to get soft and irritated by contact with wet clothing or discharges, a bed-sore is likely to be the result. With careless nursing great destruction of tissue may occur before the existence of the bed-sore is discovered. The part may be complained of by the patient as numb or tender or prickling, and the part looks red, or in more advanced stages livid or purple or black. A dark slough finally forms, and separates by ulceration, shreds and larger pieces being detached, till a large sore is

CHANGING BEDS IN THE CASE OF A HELPLESS PATIENT.

I. In this case the patient is able to sit up in bed. The clean bed is brought close up to the used one. The patient is lifted by two nurses, one at each side of the bed, who each pass the arm next the foot of the bed under the patient's thighs, and the other arm across the patient's back, locking the hands in each case. The patient is then lifted steadily and carried down the bed, over the lower end, and then backwards over the lower end of the clean bed and up into position.

II. This shows an easy method of carrying a helpless patient who must be kept in the horizontal position. Four attendants are required. Two poles six feet long are taken. The handle of a long broom will do, or a pole for raising or lowering windows. These are laid lengthways one on each side of the bed, and the under sheet rolled on them close up to the patient. The top sheet and one blanket are left on the patient, who is now carried, feet first, over the end of the used bed, and then, head first, over the lower end of the fresh bed.

18d.

CHANGING BEDS IN THE CASE OF A HELPLESS PATIENT.

Plate XVIIId.

I. When the patient is able to sit up in bed, she may be carried by two nurses.

II. A helpless patient, unable to sit up in bed, being carried by four nurses.

produced with ragged undermined edges, which may enlarge with great rapidity and pass deeply into the tissues.

To prevent the formation of bed-sores a feather-bed should be discarded, care must be given to keep the draw-sheet under the patient smooth, and to keep the patient constantly clean and dry. Then the parts on which pressure is exerted must receive special attention, and this long before any signs of the formation of a sore appear. They must be washed carefully with soap and water, and then thoroughly dried. Then there is to be gently rubbed into the skin pure spirit of wine, or eau de Cologne or whisky or brandy may be used. This is to be rubbed in till the skin is quite dry. The parts are then dusted with fine dusting powder; a quantity of powder is not to be put on, only enough to ensure the smoothness of the skin. The quantity should not be perceptible. Finally, pressure on the part is to be removed by the adjusting of air-cushions (Plate XIX., fig. 11), water-cushions, or pads of some kind. When a water-bed can be had it will greatly diminish the tendency to the formation of sores. The process of washing, bathing with spirit, &c., must be performed several times a day; and every part of the body carefully scrutinized at frequent intervals. If the surface appears abraded the same precautions must be carried out, and the air-pillows carefully adjusted. A lotion of 2 grains bichloride of mercury in 1 ounce of spirit is used to touch the surface. [*This is strongly poisonous.*] If a sore has actually formed, it requires the treatment of a bruised wound (p. 972). It is specially difficult to keep down fœtor; and for this purpose Condy's fluid in water, Sanitas, or some of the other antiseptics or disinfectants named on p. 910, must be freely used. The nurse must be careful that after such dressing of the wound no wet things are left about the bed, and that the clothes are made perfectly free from folds.

Medical and Surgical Appliances.

Plate XIX. contains illustrations of some of the more common appliances made use of in the sick-room. Several of these have been sufficiently referred to in the previous paragraphs. Figs. 1, 2, and 3 are all useful in various affections of the throat and chest. The spray-producer is used with any of the spray solutions mentioned on p. 919. The solution is put into the bottle, and the ball at the end of the tube is rapidly compressed and relaxed. The ball covered with netting is untouched by the hands. It is for the purpose of maintaining a steady stream. For sore throat the spray produced is useful. It may also be used for diffusing antiseptic solutions through a sick-room, or for spraying bed or body clothing with disinfecting solutions, or for diffusing perfume. It is also called an **atomizer.** Fig. 3 shows one kept working by steam. One fills the tin over the flame with water through the tube projecting above the handle. The solution —cold—is put in the bottle. This is used as an inhaler for inhaling medicated solutions. The person applies his mouth to the small end of the funnel-shaped piece, and breathes in the steam, which may be impregnated with terebene, eucalyptol, &c., by adding to the water in the bottle a few drops, 5 or 10, of any of these substances. Coghill's inhaler, fig. 2, is employed in lung affections. Between the double perforated wall is laid a piece of lint, cut to fit, and of a size large enough to cover all the openings. Five or ten drops of terebene or similar substance are sprinkled on the lint; the two parts are then pressed together, and the inhaler is put over the mouth, the band being fixed at the back of the neck. The person inhales by the mouth and breathes out by the nostrils. Maw's inhaler is shown in fig. 4. The vessel is half-filled with boiling-water, 5 or 10 drops of the eucalyptol, a tea-spoonful tincture of benzoin, or other material, are dropped in, the stopper is put in, and then the patient applies his mouth to the side piece and inhales the medicated steam. Fig. 5 shows an old form of enema syringe; the form commonly used is seen in Plate VIII. The **nasal douche** (fig. 6) is an arrangement of great value in treating chronic discharge from the nostril. It consists of 2 or 3 feet of india-rubber tubing of the size used for feeding bottles. At one end is attached a conically-shaped piece of bone or vulcanite with a channel bored through it for a nose-piece. At the other end is attached a piece of glass with a bend which dips into a glass of water, the bend passing over the edge of the glass. The glass is filled with the solution to be used for washing out the nostrils, and is set a foot or two above the head of the person, who applies his mouth to the nose-piece end, and by suction fills the india-rubber tube. The tube is now a syphon, and the water will continue to flow till the lower end of the tube in the glass is uncovered, or till the nose-piece end is raised up to the level of the glass. The flow being established, the person pinches the india-rubber tube to arrest it, till the nose-

piece is adjusted. It is fitted into the *healthy nostril*, and the tube released. The person slightly stoops over a basin, and the water passes up one nostril to the back of the throat, flows into the posterior opening of the other nostril, down which it flows, washing the nostril, and is caught in the basin. Just at first the person will find a very little difficulty in preventing the water passing down the gullet, but by keeping the mouth open, and raising the palate by an action the person will speedily learn for himself, all this is prevented, and the washing process quite easily accomplished. A good solution to use to a pint of water is half a tea-spoonful of salt and the same quantity of bicarbonate of soda.

A catheter is not shown in the figure. It is an instrument for passing up into the bladder to draw off the urine. The only kind of catheter a patient should use on himself is a soft, flexible catheter, preferably the Mercier catheter, one with a bend near the point. The catheter is first dipped into warm water to make it quite flexible; it is then oiled with the finger, not dipped into oil, and then the person takes a short hold of the instrument and passes it gently into the urinary opening, passing it in bit by bit. After use it should be thoroughly cleaned by allowing warm water to pass through it. No one can do harm by using a flexible catheter, while a metal instrument may do very serious mischief in the hands of an unskilled person.

Fomentations.—Make a thick pad of flannel of the desired size, place it in a basin of boiling water, and when it is quite hot lift it out by means of a stick and throw it into a large towel. Let two persons seize the ends of the towel, one at each end, and twist them up, so wringing it and the flannel within it tightly. Apply it over the part, and cover it over with oiled silk or a thick pad of dry hot flannel. When frequent fomentations are needed, a potato steamer (Plate XIX., fig. 13) may be used for keeping them ready for use. A hot-water bottle is a convenient means of applying dry heat. It should always be enveloped in flannel to guard against burning, and the same with hot bricks, &c.

Poultices.—A poultice is usually made by heating a bowl with boiling water, placing in it the desired quantity of linseed-meal, pouring on boiling water and stirring till the required consistence is obtained. It is then spread on the cloth and covered by a layer of muslin, and applied as hot as can be borne. The writer has found that the number of people who can make a good hot poultice in this way is limited; and a half-cold poultice is worse than useless. On that account the directions he gives are as follows: Take a piece of flannel considerably longer than the poultice is to be, lay it on a board, an ironing board for instance, and set it in front of the fire to warm. Set a large dinner plate on the hot plate of the stove. Have a large basting needle and thread ready, also a piece of muslin to cover the face of the poultice; unfasten the patient's clothing so that everything is in readiness. Put the linseed-meal and water into a pot and bring to the boiling point, as one would do with porridge. When the mixture is of the consistence of porridge take off the pot, and pour the mixture on to the middle of the flannel; with rapid movements of a knife or spoon spread it evenly on the flannel to the desired size, and not too thickly. A very thick poultice is also very heavy. Lay over it the piece of muslin, fold down the edges of the flannel over the sides of the poultice, and quickly run a basting thread right round. Then double the poultice on itself, place it on the heated plate, cover it with warm flannel, and carry it to the patient. It will be so hot that there is plenty of time to adjust it. Place it on the desired part, cover with the piece of warm flannel, and fix it on firmly by a flannel binder. Remove it before it is cold. If it is not to be renewed, it may be slipped out from below the binder without disturbing anything else. For a mustard poultice the writer advises the same method. The linseed is put on the fire, and, when ready, a layer of it is spread on the flannel the desired size, but with only half of the linseed porridge. To the remainder in the pot the mustard is added, and, without putting the pot on the fire again, the two are thoroughly mixed. This mixture is now spread on the top of the first layer. That is to say, the poultice is in two layers, the layer next the flannel is without mustard, the layer above it is mixed with mustard, and is the layer that goes next the patient. The muslin is then laid on, and the rest of the process is as before. The usual quantity of mustard is 1 of mustard to 3 of linseed-meal, or equal parts of each. **Bran poultices** are made as linseed-meal poultices. **Bread poultices** are made with bread crumbs in sufficient quantity over which boiling water is poured till a sufficient consistence is obtained, the whole being thoroughly mixed into a soft mass. **Charcoal poultice:** Take 4 ozs. bread crumbs, 3 ozs. linseed-meal, 1 oz. powdered charcoal, 1 pint boiling water.

APPLIANCES FOR THE SICK-ROOM.

Plate XIX

1. Spray Producer.

2. Coghill's Inhaler for antiseptic vapours.

3. Adams' Inhaler — Spray produced by steam.

4. Maw's Inhaler.

5. A form of Injection Apparatus.

6. Arrangement of india-rubber tube and nose piece for washing out the cavity of the nostrils by a stream of water medicated or otherwise from a vessel placed above the person.

7. Arrangement of glass for holding ice.

8 & 9. Medicine Measures. a tea spoon and table spoon doses. b. c. d. drop measures.

10. India-rubber tube and mouth piece attached by a clip to a tumbler to enable a sick person to drink without raising the head or moving the tumbler.

11. Air-Cushion for relief of bed-sores.

12. India-rubber Bag for the application of Ice to the head chest &c.

13. Potato Steamer. A means of supplying cloths for fomentations.

14. Bed Urinal for males. 15. for females.

Mix the bread, meal, water, and half the charcoal in a warm bowl, spread on warm flannel, and sprinkle the remainder of the charcoal on the surface. It is used to disinfect and remove fœtor, for foul sores, bed-sores, &c.

Leeches are employed to draw fresh blood from the neighbourhood of an inflamed part, never to remove blood already effused. The small end of the leech is the mouth end. To apply it, wash and dry the part thoroughly. Meanwhile let the leech be swimming about in a vessel of water. When ready, take up the leech between the wet folds of a piece of clean lint and apply it to the desired part. It may be kept there by inverting over it a wine-glass. If several must be applied at once this is a suitable way of doing it. If the leech delays to bite, touch the part with a drop of sugar and water or milk. When the leech has withdrawn all it can, which usually occupies twenty minutes or more, it will drop off. When it does so put it into a vessel of water, a wide-mouthed bottle, for example, and cover the mouth very securely by a piece of cloth firmly tied below the edge. If a paper cover be used prick a few pin-holes in it. If the leech will not let go, do not pull it away, but sprinkle a few grains of salt upon it; it will relax its hold immediately. *Always be careful to dispose effectually of leeches that are no longer needed; and if leeches are being kept for any purpose, one cannot be too careful to have them securely fastened in their receptacle.* If they are carelessly tied up they will squirm their way out, and one cannot tell where ultimately they may wander, or what mischief they might succeed in doing. If it is desired to keep a leech bite bleeding, place a warm poultice over it; if it is desired to stop it, take a small piece of lint round the point of the finger and press firmly on the bite. Pressure with a thimble guarded by a piece of lint, will do. The bleeding will be stopped if pressure is kept up long enough. It is always proper to place a leech on a spot which can easily be compressed against a bone to stop the bleeding. For instance, a leech ought never to be put on the neck, nor over a vein. Glass tubes are provided to aid in the application of leeches.

Suppositories are small cones, like miniature sugar-loaves, made with cocoa butter and containing some active drug like morphia, belladonna, &c., for passing up into the bowel. They are quite easily introduced, specially if touched with oil. **Pessaries** are similar preparations, but larger, for the vaginal passage.

A FEW RECIPES FOR SICK-ROOM COOKERY.

1. Beef-tea. See p. 627.

2. Peptonized Beef-tea. See p. 847.

3. Peptonized Milk, Sago, &c. See p. 847.

4. Beef-tea with Oatmeal.

Mix two table-spoonfuls of oatmeal very smoothly with two spoonfuls of cold water, add a pint of strong beef-tea. Boil together for 5 or 6 minutes, stirring well all the time. Strain through a sieve and serve (*Ringer*). Arrowroot or corn-flour may be used instead of oatmeal, and needs no straining.

5. Beef-tea Pudding.

Stew 1 ounce of well-washed sago in half a pint of water till it is reduced to a half. Beat up one egg in a tea-cupful of cream, and slowly add this to the sago with constant stirring. Then add with constant stirring 4 tea-cupfuls of strong hot beef-tea.

6. Vegetable Soup.

Take two large peeled potatoes, an onion, and crumb up ½ lb. stale bread; put them into a quart of water and boil down to a pint. Strain and add a few sprigs of parsley and a small quantity of salt, and, if desired, pepper. Cover and allow to get cold. It may be warmed for use. When animal food is not allowed, this is a good article of diet (*Wood*).

7. Veal Jelly.

1 lb. lean veal, 1 breakfast-cupful of water, a piece of turnip the size of an egg, a pinch of salt. Slice the veal very thinly, and put it in a jar alternately with slices of the turnip cut very thinly, to which add the small pinch of salt and the water. Cover the jar very tightly with a paper, and put it in a saucepan of boiling water, coming more than half-way up the jar. Boil continuously for 4 hours. Then strain and use.

8. Bread Jelly.

Take the crumb of a loaf, break it up, pour boiling water over it, and leave it to soak for 3 hours. Then strain off the water and add fresh. Place the mixture on the fire and let it boil till it is perfectly smooth. Take it out, press out the water, flavour to taste, press it into a mould, and turn it out when it is required for use.

9. Port Wine Jelly.

To a pint of port wine in a jar add 1 ounce of the best gum arabic and 1 ounce fine gelatine.

and a grated nutmeg. Let them stand an hour. Then put the jar into a sauce-pan over a slow fire till all is thoroughly dissolved. Add sugar according to taste. Strain it into a flat dish, and when it is nearly cold cut into squares.

10. Water Panada.

Put a pint of cold water and two slices of dry bread into a stew-pan and boil for three quarters of an hour, stirring occasionally. Add salt, stir in the yolk of an egg, flavour to taste, and serve.

11. Milk Panada.

To a tea-cupful of stale bread-crumbs add boiling water sufficient to cover them, and when they are soft mix thoroughly. Put the mixture into a pint of milk, boil and stir till it thickens. Sweeten, or add salt, and flavour according to taste.

12. Egg Nogg.

Best French brandy, 4 ounces; cinnamon water, 4 ounces; yolks of two eggs; sugar, ½ ounce. Rub the sugar and egg yolks together, then add the rest; or,

13.

Beat a whole egg for 5 minutes, adding a small quantity of sifted sugar and a cup of milk, warm or cold. To this may be added a small quantity of wine or brandy and a grated nutmeg. If milk is not desired, beat the egg and sugar together and add the wine or brandy.

14. Brandy and Egg Mixture. See Prescriptions, No. 63.

15. Oatmeal Gruel.

Put into a small basin a table-spoonful of Scotch oatmeal. After wetting it with a very little cold water, pour over it a pint of boiling water or milk, stirring all the time. Stir it for a few minutes, then allow it to settle one minute. Pour carefully into a clean sauce-pan all the liquid, and stir over the fire till it boils. Let it boil for 10 minutes, when it is ready for use. It may be sweetened with honey, sugar, or treacle; or it may be flavoured with salt and a small piece of butter. It should be taken very hot (*Mrs. Black*).—Or,

16.

Use the same quantity of oatmeal, a little more than half the quantity of boiling water, and salt to taste, and boil as directed. Then add half a pint of butter-milk, and a little bit of butter.

17. Black Currant Jam Water.

Two table-spoonfuls of jam are added to 4 tea-cupfuls of water in a sauce-pan and allowed to simmer for half an hour, and then strained. It may be drunk hot in cases of feverish sore throat, or after it has become cool for thirst.

18. Barley Water.

Wash 1 table-spoonful of barley, put it into a jug with the rind of one lemon and a tea-spoonful of sugar. Pour over it 3 tea-cupfuls of boiling water; then cover the jug and let it stand till cold. Pour off the liquid for use.

19. White Wine Whey.

To a breakfast-cupful of boiling milk add one or two wine-glassfuls of sherry. Strain through a fine sieve and sweeten with sifted sugar.

20. Oatmeal Water.

Put a large table-spoonful of oatmeal into a jug, and pour over it a pint of cold water. Stir well, allow the meal to settle. Then strain and use the water, flavoured if desired.

PRESCRIPTIONS.

The accompanying prescriptions are arranged in divisions in the following order:—

I. Tonic mixtures.
II. Purgative „
III. Diarrhœa „
IV. Fever „
V. Stimulant „
VI. Soothing „
VII. Cough „
VIII. Gargles, Mouth Washes, Tooth Powders.
IX. Liniments, Lotions, and Washes, including Eye Washes and Ointments, and Hair Washes.

In the prescriptions the weights and measures used are as follows:—

1 fluid ounce = 8 fluid drachms.
1 fluid drachm = 60 drops.
1 tea-spoonful means 1 fluid drachm or 60 drops.
1 dessert „ „ 2 „ drachms or 120 „
1 table-spoonful means 2 dessert-spoonfuls or 4 tea-spoonfuls, and is equal to ½ fluid ounce.
The measure by weight is 60 grains 1 drachm, 8 drachms 1 ounce.

I.—TONICS.

Simple Acid Tonics.

1. *Dilute Hydrochloric Acid,*
Dilute Sulphuric Acid,
Dilute Nitro-Hydrochloric Acid, or
Aromatic Sulphuric Acid.

Any of these acids is useful as a general tonic in debility, in some forms of indigestion (see pp. 158 and 179), in looseness of bowels from catarrh (p. 179), in liver complaints (see p. 195), and similar disorders.

The dose is the same for each acid, namely, from 10 to 20 drops in a wine-glassful of water, taken after food. For a child 5 drops are sufficient. The aromatic sulphuric acid in water relieves thirst and checks profuse perspiration.

Acid Tonic with Quinine.

2. *Aromatic Sulphuric Acid,* 6 *fluid drachms.*
Sulphate of Quinine, . 24 *grains.*
Syrup of Orange, . . 2 *ounces.*
Water, ... *up to* 8 „

Dose: One table-spoonful in the same quantity of water thrice daily.

Useful in depressing disorders, see *Carbuncle* (p. 315).

Acid Tonic with Bark (Peruvian).

3. *Dilute Sulphuric Acid,* . . . . ½ *ounce.*
Compound Tincture of Cinchona, 1½ *ounces.*
Syrup of Orange, ... 2 „
Infusion of Yellow Cinchona, up to 8 „

Dose: One table-spoonful in water twice or thrice daily with meals.

As a general tonic and in depressed states.

Bark as a Tonic.

4. Any of the *Cinchona Barks* in powder may be used alone as a tonic in doses of 15 grains, or the tincture in doses of ½ to 1 tea-spoonful in water. They are useful in checking looseness of bowels, sweating, &c.

5. *Tincture of Red Cinchona Bark* has a repute in allaying the craving for spirit of chronic drunkards (see p. 105).

Bitter Tonic.

6. *Tincture of Nux Vomica,* . 8 *drops.*
Infusion of Chiretta, . *up to* 4 *ounces.*

Dose: A fourth part taken before meals.

Useful as an aid in slow digestion.

Bitter Tonic with Ammonia or Soda.

7. *Aromatic Spirit of Ammonia,* . . ½ *ounce.*
Compound Tincture of Cardamoms, 1 „
Infusion of Calumba, . . *up to* 8 *ounces.*

Dose: A table-spoonful before meals.

8. Instead of the Aromatic Spirit of Ammonia *Bicarbonate of Soda or Potash* (80 *grains*) may be dissolved with the bitters.

Bitter Tonic with Acid.

9. *Dilute Hydrochloric Acid,* . . 3 *drachms.*
Tincture of Nux Vomica, . . 40 *drops.*
Infusion of Chiretta, . . *up to* 4 *ounces.*

Dose: A dessert-spoonful in a like quantity of water to be taken after meals.

These bitter tonics are all useful to rouse the stomach and aid digestion (see p. 179). The simple bitters, as well as those with ammonia, soda, or potash, should be taken immediately before meals, that with acid immediately after meals. The last is specially useful where indigestion is accompanied by sluggish and loaded liver (see p. 195), and in flatulent indigestion (see p. 181).

Simple Iron Tonics.

The simplest iron tonic is—

10. *Tincture of Steel.*

Dose: 10 drops in water five times daily.

It is useful in erysipelas (see p. 315), and in most conditions of ill-health dependent upon a poor quality of blood (see Anæmia, p. 234).

11. *Dialysed Iron.*

Dose: 5 to 15 drops in water four or five times daily.

Useful in weak conditions of body, rickets (see p. 30), and bloodlessness (anæmia, see p. 235). It is less binding to the bowels than tincture of steel.

Iron and Quinine.

12. *Tincture of Steel,* . . . . $2\frac{1}{2}$ *drachms.*
Sulphate of Quinine, . . . 48 *grains.*
Syrup of Orange, ... $1\frac{1}{2}$ *ounces.*
Water,[1] . . . . . *up to* 4 „

Dose: A tea-spoonful in half a wine-glassful of water some time after food.

A good general tonic.

Iron, Quinine, and Strychnine.

13. *Citrate of Iron and Quinine,* . 90 *grains.*
Liquor Strychniæ, ... 90 *drops.*
Water, ... *up to* 4 *ounces.*

Dose: A tea-spoonful in a table-spoonful of water thrice daily, an hour or more after food.

A good general and nerve tonic.

14. *Easton's Syrup* consists of a combination of iron, quinine, and strychnine, and is a useful tonic for debility.

The dose is a tea-spoonful in water.

The combinations with strychnine are useful in weak conditions, accompanied by nervous exhaustion and debility.

Iron and Arsenic.

15. *Citrate of Iron and Quinine,* $2\frac{1}{2}$ *drachms.*
Liquor Arsenicalis, . . . 60 *drops.*
Tincture of Quinine, . . . 2 *ounces.*
Syrup of Orange, ... 2 „
Water, ... *up to* 8 „

Dose: A dessert-spoonful in two-thirds of a wine-glassful of water.

Useful in skin diseases (see p. 317), in impoverished conditions of the blood, see *Anæmia* (p. 235), and purpura (p. 237), in nerve affections, such as neuralgia (see p. 127).

Iron and arsenic are also extensively used in various diseases of women (see p. 509).

[1] Chloroform water instead of plain water would make this mixture more palatable.

Iron and Phosphorus.

16. *Reduced Iron,* . . . . 50 *grains.*
Sulphate of Quinine, ... 25 „
Phosphorus, ... $\frac{1}{4}$ *grain.*
Extract of Nux Vomica, . . . 13 *grains.*
Extract of Gentian, ... 25 „

To be made into a pill mass and divided into 25 pills.

Dose: One pill thrice daily *on a full stomach.*

This is an exceedingly useful pill in most cases of nervous depression, nervous headache, neuralgia (p. 127), and nervous irritability, the result of exhaustion. On p. 113 the prescription for a stronger pill is given.

Iodide of Iron.

17. *Syrup of the Iodide of Iron* is the form in which this combination of drugs is usually ordered.

Dose: One half to one tea-spoonful in water three or four times daily. For very young children a quarter of a tea-spoonful is sufficient.

In all cases of illness associated with scrofula (p. 431) this is one of the best remedies. In scrofulous inflammation of bone (p. 26), scrofulous diseases of glands (p. 209), &c., it is very useful.

18. *Compound Syrup of the Phosphate of Iron* (Parrish's Syrup or Chemical Food), and

19. *Compound Syrup of the Hypophosphites,* are now both very extensively used for the treatment of cases of general debility, specially in the young. Various forms of No. 19 are now in the market, all more or less useful.

The dose in the case of any of these is from a third to one tea-spoonful (according to age) in water thrice daily a short time after food.

Iron and Chlorate of Potash.

20. *Chlorate of Potash,* . . . . 90 *grains.*
Dialysed Iron, ... $\frac{1}{2}$ *ounce.*
Syrup of Orange, ... $1\frac{1}{2}$ *ounces.*
Water, ... *to* 4 „

Dose: A tea-spoonful in water four times daily.

Useful for those subject to relaxed throat (p. 157) or to attacks of inflamed tonsils.

II.—PURGATIVE MIXTURES AND PILLS.

Castor-oil.

21. Castor-oil may be taken as a safe purgative, at any time, in doses of from 2 to 3 tea-spoonfuls. Its taste may be entirely disguised by mixing it with a tea-cupful of beef-tea well peppered and salted. Or it may be mixed with half a tea-cupful of boiling milk. The boiling milk is gradually added in small quantities, being thoroughly stirred with the oil, till the oil is thoroughly incorporated with the milk, no large globules of oil being visible. *The milk must be boiling, and must be slowly added with constant stirring.*

Castor-oil and Laudanum.

22. *Castor-oil,* . . . . . 1 *ounce.*
Tincture of Rhubarb, . . 1 *tea-spoonful.*
Laudanum, ... 15 *drops.*
Syrup of Orange, . . . 1 *tea-spoonful.*
Cinnamon Water, . . . ½ *ounce.*

Mix. The addition of two tea-spoonfuls of mucilage of gum arabic or gum tragacanth will permit of an emulsion being formed.

This mixture is very useful in looseness and irritability of bowels, due to irritating material in the bowel. After the opening effect is produced, clearing out the bowel, the soothing effect of the laudanum and the astringent action of the rhubarb come into play arresting further action.

This is only for adults.

Epsom Salts.

23. *Epsom Salts,* . . . . . . ½ *ounce.*
Acid Infusion of Roses, . . 2 *ounces.*

Add to any desired quantity of water. To be taken early in the morning.

This may be used for any feverish complaint, such as inflamed sore throat (p. 155) or feverish cold (p. 158) of the stomach.

Black Draught.

24. *Epsom Salts,* . . . . . . 4 *ounces.*
Rochelle Salts, ... 2 „
Essence of Senna, ... 7 „
Aromatic Spirit of Ammonia, . 1 *ounce.*
Compound Tincture of Cardamoms, ... 1 „
Water, ... 16 *ounces.*

Take three or four table-spoonfuls in water early in the morning.

This is found to be a valuable purgative after a drinking bout, as a relief to the headache and stomach and liver disorder.

Seidlitz Powder.

25. *Rochelle Salts,* . . . . . 120 *grains.*
Bicarbonate of Soda, . . 40 „

Dissolve in a tumblerful of water and then add 37 grains of tartaric or citric acid. Stir and drink during effervescence.

This is taken in the morning as a mildly opening draught.

Fruit Saline.

26. *Tartaric Acid,* . . . . . 9 *ounces.*
Bicarbonate of Soda, . . . 10 „
Chlorate of Potash, . . . ¼ *ounce.*
Epsom Salts, ... 3 *drachms.*
Powdered Sugar, ... 3 *ounces.*

Or,

27. *Tartaric Acid,* . . . . . 13 *ounces.*
Bicarbonate of Soda, . . . 14 „
Chlorate of Potash, . . . ½ *ounce.*
Epsom Salts, ... 2 *ounces.*
Sugar, ... 1½ „

Mix. Note each ingredient should be well dried before mixing.

These salines are useful as a mild opening medicine to be taken in early morning, 2 or 3 tea-spoonfuls in ½ tumblerful of water. In feverish states they may be safely taken by any one.

Lamplough's Pyretic Saline.

28. *Tartaric Acid,* . . . . . 9 *ounces.*
Bicarbonate of Soda, . . . 10½ „
Chlorate of Potash, . . . 3 „

Mix. Use as above.

Calomel and Jalap.

29. *Calomel,* . . . . 5 *grains.*
Powder of Jalap, ... 15 „

Mix. Give in a little water; three hours later give the following draught:—

30. *Epsom Salts,* . . . ¼ *ounce.*
Manna, ... 60 *grains.*
Tincture of Jalap, . 2 *tea-spoonfuls.*
Cinnamon Water, . 2½ *table-spoonfuls.*

This is the prescription for threatened affections of the head (see p. 101, inflammation of the membranes of the brain), and to reduce the stage of excitement that follows injuries to the head (see p. 104). It is also useful to relieve a loaded liver (p. 197, 198), and as an active purgative at the beginning of many acute diseases, inflammation of the kidney or lung for example.

Calomel and Rhubarb for Children's Powders.

31. *Calomel*, ... ½ *to* 2 *grains.*
Powdered Rhubarb, . . . 3 *to* 8 „
Aromatic Powder, ... 4 „

This may be given to children in cases of thread-worm (p. 174), in feverishness accompanying teething, and in head affections in children. For instance, if a child has had a fall or blow on the head it is well to give such a powder by way of preventive of nervous excitement following. The actual dose depends upon the age. The amount named would be suitable for children between 1 and 5 years, the smaller dose noted for the younger child.

Grey Powder and Soda for Children.

32. *Grey Powder*, ... ½ *to* 3 *grains.*
Carbonate of Soda, ... 6 „
Sugar of Milk, ... 3 „

This is suitable for disordered states of the bowels in children where there is looseness of bowels, and the motions are curdy white, with pieces of undigested milk throughout. One morning and evening may be given.

In regard to grey powder the general rule for what are called "Cooling Powders" is, for a child between 1 and 6 months, ½ grain grey powder, 6 grains of the soda; for a child between 6 and 12 months, 1 grain grey powder, 6 of soda; between 1 and 3 years, 1½ grains grey powder, 6 soda; and between 4 and 8 years, 3 grains of grey powder with 6 of soda.

Jalap and Senna.

33. *Compound Jalap Powder*, 30 *to* 60 *grains.*
Syrup of Senna, . . . 1 *tea-spoonful.*
Camphor Water, . . . 4 *table-spoonfuls.*

Mix and give in water early every morning. This promotes a watery discharge from the bowel, and is useful in dropsy consequent upon liver disorder (see p. 435).

Aloes.

34. *Tincture* (*or Wine of Aloes*), 1 *tea-spoonful.*
Infusion of Senna, . . 2 *table-spoonfuls.*
Epsom Salts, ... ¼ *ounce.*

Mix and take in water in early morning.

The aloes acts principally on the large bowel, and is specially useful in habitual costiveness, with hard dry motions. The following is an excellent pill, containing the active principle of aloes, namely aloin, in cases of constant constipation, specially when it is due to want of sufficiently active exercise in the open air.

35. *Aloin*, ... *gr.* ⅕
Extract Belladonna, ... *gr.* ⅙
Extract of Nux Vomica, . . . *gr.* ½
Hard Soap, ... *gr.* ½

Make into a pill. Let one such pill be taken either at bed-time, in which case it should act after breakfast next morning, or in early morning, in which case it should act after dinner.

Podophyllin.

36. *Resin of Podophyllin*, ... *gr.* ⅓
Extract of Nux Vomica, ... *gr.* ½
Extract of Hyoscyamus, ... *gr.* 1
Hard Soap, ... *gr.* ½

Make one pill. Take one such pill before breakfast each morning. This is a very suitable pill for sluggish liver and the costiveness that usually accompanies it (p. 195), and it relieves at the same time the indigestion and headache that are usually produced by it.

Rhubarb and Magnesia.

37. *Carbonate of Magnesia*, . . . 10 *grains.*
Powdered Rhubarb, ... 5 „
Aromatic Powder, ... 5 „

This is a suitable powder for feverish conditions in children and for disordered states of stomach and bowel (p. 460).

Another way of administering the same remedies to infants is as follows:—

38. *Powdered Rhubarb*, . . . 15 *grains.*
Carbonate of Magnesia, . 60 „
Dill Water, ... 3 *table-spoonfuls.*

Give of this mixture a tea-spoonful every two hours till the bowels are freely opened.

Mixture for Gout.

39. *Sublimed Sulphur*, ... 2 *ounces.*
Cream of Tartar, ... 1 *ounce.*
Powdered Rhubarb, ... ¼ „
Resin of Guaiac Powder, . . 1 *drachm.*
Honey, ... 1 *pound.*
One Nutmeg reduced to powder.

Mix thoroughly.

This is a mixture formerly in much repute for gout and chronic rheumatism, and was well known under the name of the "Chelsea Pensioner." The dose is 2 tea-spoonfuls night and morning till the whole is consumed.

III.—DIARRHŒA MIXTURES.

The few mixtures for diarrhœa that will be mentioned here are not to be given at random. Let the reader refer to Diarrhœa (p. 184), and to the paragraphs on Remedies

for Diarrhœa (p. 866). It is possible that by acting on the instructions given there, the looseness of bowels may be checked without the use of any astringent remedies, which by their binding effect tend to cause costiveness afterwards. The following prescriptions are to be resorted to only if simpler means fail, or if pain, griping, and excessive discharge make the case urgent:—

Bismuth and Ipecacuanha.

40. *Carbonate of Bismuth*, . . . 10 *grains*.
Powder of Ipecacuanha, . . 5 „

Mix. Give one powder every two or three hours, till the diarrhœa is checked.

Bismuth, Ipecacuanha, and Opium.

41. *Carbonate of Bismuth*, . . . 10 *grains*.
Dover's Powder (*Compound Ipecacuanha Powder, which contains* 1 *grain opium in* 10 *of powder*), ... 5 „

Mix. Give one powder every four hours if necessary.

Catechu and Chalk Mixture.

42. *Tincture of Catechu*, $\frac{1}{2}$ *ounce* (1 *table-spoonful*).
Oil of Peppermint, . . 6 *drops*.
Aromatic Chalk Powder, 90 *grains*.
Chalk Mixture, . . *to* 8 *ounces*.

Give an eighth part after each loose motion. If this treatment fail, add 8 drops of laudanum to each dose.

It is well to make certain, before giving this mixture, that no irritating material is lodging in the bowel by administering a table-spoonful of castor-oil three or four hours before the mixture is begun, if the case is not too urgent.

43. Ipecacuanha Powder used in large doses, as detailed on p. 852, is given in the Tropics for dysentery.

44. *Liquid Extract of Bael Fruit*, ... 1–2 *tea-spoonfuls*.
Syrup of Red Gum, . . 1 *tea-spoonful*.
Water, ... 1 „

Mix. This is recommended for chronic dysentery (p. 186) given three or four times a day.

Diarrhœa Mixtures for Children.

45. *Carbonate of Bismuth*, . 80 *grains*.
Ipecacuanha Wine, . . 80 *drops*.
Aromatic Spirit of Ammonia, ... $1\frac{1}{2}$ *tea-spoonfuls*.
Simple Syrup, . . . $\frac{1}{2}$ *ounce* (1 *table-spoonful*).
Mucilage of Gum Arabic, $\frac{1}{2}$ *ounce*.
Water, ... *to* 2 *ounces*.

Mix. Give a tea-spoonful every three hours to a child 1 year old, and half the quantity to a 6-months'-old child. If it were absolutely necessary, one drop of laudanum might be added to the dose for the year-old child. But this should not be done unless medical advice is not within reach.

46. *Aromatic Powder of Chalk and Opium*, ... 20 *grains*.
Carbonate of Bismuth, . . . 60 „

Mix and divide into 10 powders. One of these could be given every third hour to a child 1 year old. Note that in aromatic chalk and opium powder there is $\frac{1}{2}$ grain of opium in the 20 grains of the powder, so that in each of the 10 powders there would be $\frac{1}{20}$th grain of opium.

Diarrhœa with Blood in the Motions.

47. The *Catechu and Chalk* mixture (No. 42) may be used with the addition to each dose of 5 drops tincture of witch-hazel or *Hamamelis virginica* (p. 835), or 1 tea-spoonful of the American preparation, Pond's extract, or the same quantity of the English preparation, hazeline. The following may also be taken:—

48. *Tincture of Steel* (*steel drops*), ... 15 *drops*.
Dilute Hydrochloric Acid, 10 „
Orange Flower Water, 3 *table-spoonfuls*.

Mix and take the whole quantity in water, to be repeated every 6 hours.

The same may be used in bleeding from the stomach. See also p. 835.

IV.—FEVER MIXTURES.

Quinine.

49. *Quinine* is often the best drug to use in cases where there is considerable fever. It is sometimes best given alone, simply stirred in a wine-glassful of cold water.

Dose: 3 to 5 grains every 4 or 6 hours.

In cases where the fever heat is very great, such as cases of acute inflammation of glands (p. 207), or of blood poisoning (p. 236), or in cases of ague (p. 427), a large dose should be given at once, namely:

10 grains, and it may be repeated in six hours.

Salicine.

50. *Salicine* or Salicylate of Soda is one of the most quickly acting remedies in rheumatic fever (p. 430).

Dose: 20 grains in water every two hours

till the pains are relieved. Thereafter four doses daily for several successive days.

Quinine and Salicine.

51. *Quinine*, ... 5 *grains*.
Salicine, ... 20 „

This makes one powder to be given all at once.

This is a combination useful in some feverish conditions. It is specially useful in neuralgic affections (p. 127).

52. *Antipyrin* and its use in fever is sufficiently detailed on p. 821.

Dover's Powder.

53. *Dover's Powder* is useful at the very outset of a feverish cold (see *Catarrh*, p. 154, and *Cold in the Stomach*, p. 158), inflammation of the bowels (p. 162), and child-bed fever (p. 518).

Every 10 grains of the powder consist of
Powdered Opium, ... 1 *grain*.
Powdered Ipecacuanha, . . . 1 „
Sulphate of Potash, ... 8 *grains*.

Dose: 10 grains given in water.
It must never be given to children.

Acetate of Ammonia.

54. *Liquor Acetate of Ammonia*, . . 5 *ounces*.
Simple Syrup, ... $1\frac{1}{2}$ „
Water, ... *to* 8 „

Dose: From a tea-spoonful (for children) to a table-spoonful (for adults) in water every three hours.

Used in all feverish diseases, especially in those accompanied by skin eruption. It promotes sweating and this reduces the fever.

Ammonia and Ether.

55. *Liquor Acetate of Ammonia*, . 3 *ounces*.
Spirit of Nitrous Ether, . . . 1 *ounce*.
Simple Syrup, ... 1 „
Water, ... *to* 6 *ounces*.

Dose: From a tea-spoonful to a table-spoonful (according to age) in water every three hours.

Useful in the beginning of most fevers.

Another prescription for Ammonia and Ether is given on p. 402.

V.—STIMULANT MIXTURES.

Ammonia.

56. *Carbonate of Ammonia*, . . . 80 *grains*.
Syrup of Ginger, ... 1 *ounce*.
Water, ... *to* 4 *ounces*.

Dose: Two tea-spoonfuls in water every four hours.

Useful in faintness, wind on the stomach (p. 243), in nervous and hysterical persons, and as a general stimulant.

Ammonia and Ether.

57. *Carbonate of Ammonia*, . . 120 *grains*.
Chloric Ether, ... 3 *drachms*.
Infusion of Senega, . . . 6 *ounces*.

Dose: A dessert-spoonful in a wine-glassful of water every three hours.

A valuable stimulant in chronic bronchitis (p. 271), and in exhaustion in cases of inflammation of the lungs (p. 275), and other weakening diseases, such as typhoid fever.

58. *Aromatic Spirit of Ammonia*, $1\frac{1}{2}$ *ounces*.
Chloric Ether, ... $2\frac{1}{2}$ *drachms*.
Syrup of Ginger, ... 1 *ounce*.
Water, ... *to* 4 *ounces*.

Dose: A dessert-spoonful in a wine-glassful of water as required.

May be used for faintness, and giddiness in nervous people troubled with wind on the stomach (p. 181). The same is useful in hiccup (p. 182) and palpitation, and is aided by the addition to each dose of 10 drops of spirit of camphor, or the mixture may be made up to 4 ounces with camphor water instead of simple water. With the addition of camphor the mixture is useful in looseness of bowels (p. 184), and in tea-spoonful doses might be given to children.

59. *Aromatic Spirit of Ammonia*, $\frac{1}{2}$ *tea-spoonful*.
Carbonate of Magnesia, . 20 *grains*.
Spirit of Chloroform, . . $\frac{1}{2}$ *tea-spoonful*.
Peppermint Water, . *to* $1\frac{1}{2}$ *ounces*.

Make a draught with water. To be taken all at once for colic, hysterical faintness, flatulence, &c.

60. Stimulant Mixture for children with wind on the stomach and colicky pain.

Carbonate of Magnesia, . . 60 *grains*.
Sugar of Aniseed, ... 60 „
Aromatic Spirit of Ammonia, 30 *drops*.
Compound Tincture of Cardamoms, ... 2 *drachms*.
Dill Water, ... *to* 2 *ounces*.

Mix. A tea-spoonful for a dose, repeated as required.

Caffein and Guarana—Nerve Stimulants.

61. The active principle of coffee—caffein—and the active principle of the Brazilian cocoa—guarana—are useful nervous stimulants in certain cases. They are frequently used in nervous headache.

The caffein is given in doses of 1 to 5 grains in water, or may be obtained as effervescing citrate of caffein, of which a tea-spoonful in half a tumbler of water is the dose, and it may be frequently repeated.

The dose of guarana is 15 to 30 grains given in water, and repeated for a time every two hours if necessary.

Ether and Brandy.

62. *Chloric Ether,* . . . . 3 *drachms.*
French Brandy, ... $1\frac{1}{2}$ *ounces.*
Infusion of Yellow Cinchona, to 8 „

Dose: Two table-spoonfuls to be given occasionally.

In convalescence from acute diseases or in low fevers.

Brandy and Egg Mixture.

63. Beat up an egg till it froths, add a lump of sugar and two table-spoonfuls of water, mix well; pour in half a small wine-glassful of brandy, or, instead, one wine-glassful of sherry, and administer before it gets flat.

Useful in convalescence from exhausting diseases.

Brandy and Milk.

64. Pour a table-spoonful of brandy or a wine-glassful of sherry into a cup, add a little powdered sugar and very little nutmeg to taste. Warm a breakfast-cupful of new milk and pour it into a jug with a spout. Pour the milk from a height into the cup containing the brandy or wine. The milk must not be boiled.

Beef and Iron Wine.

65. Several chemists now make a preparation of beef, wine, iron, or meat and malt wine, &c.

These are useful in weak states of health, and often very useful in exhausting diseases of children.

The Beef and Iron Wine of Burroughs Welcome & Co., and the Extract of Meat and Malt Wine of Coleman, are illustrations.

VI.—SEDATIVE (SOOTHING) MIXTURES.

66. *Bromide of Potassium* is one of the simplest and safest (if not used with unnecessary frequence) of soothing drugs.

Dose: For adults, ... 30 grains.
For young children, . . 5 „

It should be dissolved in sweetened water.

It is exceeding valuable in many nervous diseases, especially epilepsy (p. 123), inflammation of the brain (p. 100) and spinal cord (p. 117), child-crowing (p. 464), somnambulism (p. 116), and sometimes sick-headache and neuralgia.

67. *Belladonna* is also very serviceable in nervous diseases, especially spasmodic diseases, such as epilepsy (p. 123). It is one of the best remedies in whooping-cough (p. 416).

At the places referred to directions are given for the use of the drug.

68. *Extract of Belladonna,* . . . $\frac{1}{6}$ *grain.*
Extract of Hyoscyamus (*Henbane*), $1\frac{1}{2}$ *grains.*
Extract of Gentian, ... 1 *grain.*

To be made into one pill.

Dose: One pill, to be repeated twice or thrice within eight hours if required.

Useful in allaying irritation of bowels and bladder (p. 305).

69. *Extract of Indian Hemp* (*Cannabis Indica*), ... $1\frac{1}{2}$ *grains.*
Extract of Henbane, ... 6 „
Extract of Gentian, ... 6 „

Make into a pill mass and divide into six pills.

Dose: One pill repeated thrice or four times daily if necessary.

This is extremely soothing in sick-headache (p. 113), in various painful diseases of women (p. 510 and 504). It is also used for sleeplessness (p. 117). In such a case the dose should not be larger than $\frac{1}{4}$ grain of the Indian Hemp to begin with.

Opium or its chief active principle morphia is one of the most powerful of soothing remedies. One mixture containing it will, therefore, be given.

70. *Liquor Hydrochlorate of Morphia,* $\frac{1}{2}$ *ounce.*
Tincture of Hyoscyamus, . . 1 „
Syrup of Orange, ... 1 „
Water, ... *to* 4 *ounces.*

Dose: A dessert-spoonful in water, to be repeated in two or three hours, only if necessary.

This mixture is likely to relieve most painful affections of the stomach and bowels, many spasmodic diseases, spasmodic cough, &c. *It ought not to be given for cough when any defluxion is brought up by coughing, and it ought never to be given to children.*

VII.—COUGH MIXTURES.

A separate paragraph relating to cough mixtures is given here mainly to warn persons against the indiscriminate use of the ordinary mixtures. Cough is certain to exist wherever

there is phlegm or matter in the air-tubes, and is the natural method of expelling the offending material. To stop cough, in such cases, is certain to do harm by causing the material to remain and accumulate in the lungs or air-passages. In such cases the proper treatment is to give medicine which will aid the expulsion of the material, and thus relieve the cough. But, in the second place, the cough may be due to irritability of the air-passages without the presence of any material to be expelled. In such cases soothing drugs are needed. For further details see p. 284. The difference may be put by calling the first class of cases that of cough with spit and the second class that of dry cough.

For Cough with Spit.

71. *Ipecacuanha Wine* 5 to 40 drops, according to age, in a table-spoonful of water.

Useful in rendering the defluxion more fluid so that it is more readily expelled.

72. *Carbonate of Ammonia*, . . . 16 *grains*.
Ipecacuanha Wine, ... 80 *drops*.
Camphor Water, ... *to* 4 *ounces*.

A dessert-spoonful every two or three hours. Useful *for children* to aid the expulsion of matter from the air-tubes in bronchitis, whooping-cough, &c.

73. *Carbonate of Ammonia*, . . 40 *grains*.
Spirit of Ether, ... 2 *drachms*.
Tincture of Squill, ... 1½ „
Tincture of Camphor, . . . 2 „
Infusion of Senega, . . *to* 4 *ounces*.

Mix: Give one table-spoonful in water every four hours.

Useful for helping the cough in the bronchitis of *old people*.

For Dry Cough.

74. *Ipecacuanha Wine* may be used as directed for cough with spit. It often gives great relief when sprayed into the back of the throat by means of the spray producer (see Plate of Appliances for the Sick-room). A few drops of the wine added to some honey and water would make a soothing mixture for children, or liquorice juice might be employed for the same purpose.

75. A very useful cough mixture when the cough is the result of irritability of the air-passages will be found under Sedative (Soothing) Mixtures, No. 70. It should not be given to children.

No cough mixture containing laudanum, or other preparation of opium, such as paregoric elixir, or a drug like chlorodyne, should be given to children without a physician's orders.

VIII.—GARGLES AND MOUTH WASHES AND TOOTH POWDERS.

Borax Gargle.

76. *Borax*, ... ¼ *ounce*.
Tincture of Myrrh, ... 1 „
Water, ... *to* 8 *ounces*.

Mix. Gargle the mouth with a small quantity added to an equal quantity of lukewarm water twice daily in cases of ulcers about the mouth and throat (p. 149), or in relaxed sore throat and inflammation of tonsils (p. 155).

Borax and Glycerine.

77. *Borax*, ... ¼ *ounce*.
Glycerine, ... 1 „

Dissolve and apply with a brush in cases of ulcers and cracks of tongue, sore throat, &c. (p. 155).

Alum Gargle.

78. *Burnt Alum*, ... 80 *grains*.
Tincture of Myrrh, ... 1 *ounce*.
Water, ... *to* 7 *ounces*.

Mix. Apply this to the gums, mouth, throat, &c., in cases similar to above.

Alum and Catechu Gargle.

79. *Burnt Alum*, ... 90 *grains*.
Tincture of Catechu, . . . 1 *ounce*.
Tincture of Cayenne, . . 1 *tea-spoonful*.
Glycerine, ... 1 *ounce*.
Water, ... *to* 4 *ounces*.

Mix. This is a very useful gargle in cases of relaxed sore throat, in which case diluted with an equal quantity of warm water it may be used several times a day. It may also be applied, full strength, by means of a camel's-hair pencil at the very onset of an inflamed sore throat.

Tannic Acid Gargle.

80. *Tannic Acid*, ... 90 *grains*.
Tincture of Myrrh, ... ½ *ounce*.
Glycerine, ... 1 „
Water, ... *to* 4 *ounces*.

Mix. In cases of relaxed sore throat, ulceration of mouth, loosening of teeth, spongy gums, this is useful diluted with three times the quantity of warm water, or applied, half strength, by a camel's-hair pencil.

Carbolic Acid and Myrrh Mouth Wash.

81. *Carbolic Acid* (*Calvert's, No.* 2), ½ *ounce*.
Tincture of Myrrh and Borax, . ½ „
Glycerine, ... 2 *ounces*.
Water, ... 1 *ounce*.

Mix. About half a tea-spoonful of the mixture in a third of a tumblerful of warm water makes a most soothing and pleasant mouth wash. It is valuable for decaying teeth and spongy gums, removes offensive odour from the breath, and is effective in removing the smell of smoke from the breath.

Chlorate of Potash Mouth Wash.

82. *Chlorate of Potash,* . . . . ¼ *ounce.*
Tincture of Myrrh, ... ½ „
Glycerine, ... 1 „
Water, ... *to* 4 *ounces.*

Mix. This diluted with three or four parts of water may be used for sore throat, as a gargle, ulcerated mouth, &c.

Iron and Glycerine Gargle.

83. *Tincture of Steel,* . . . . . 1 *ounce.*
Glycerine, ... 1 „
Rose Water, ... 1½ *ounces.*
Water, ... *to* 4 „

Mix. Diluted with equal parts of water this may be used as a gargle for sore throat, or applied full strength by a camel's-hair pencil, or diluted with three or four parts of water it may be sprayed into the throat with a spray-producer for hoarseness.

Antacid and Astringent Tooth Powder.

84. *Precepitated Chalk,* . . . . 5 *ounces.*
Magnesia, ... 1½ „
Orris Root Powder, ... ½ *ounce.*
Sugar, ... ½ „
Tannic Acid, ... 30 *grains.*
Oak Bark in Powder, . . . 5 „
Powdered Hard Soap, . . . ¼ *ounce.*
Otto of Roses, ... 10 *drops.*
Oil of Lemon, ... 2 „

Mix.

Camphorated Chalk Tooth Powder.

85. *Camphor,* . . . . 1½ *ounces.*
Orris Root Powder, ... ½ *ounce.*
Precipitated Chalk, ... ½ *lb.*

Mix.

Antiseptic Tooth Powder.

86. *Powdered Castile Soap,* . . . 60 *grains.*
Precipitated Chalk, ... 2 *ounces.*
Eucalyptus Oil, ... 60 *drops.*
Carbolic Acid, ... 30 „

Mix thoroughly.

IX.—LINIMENTS, LOTIONS, AND WASHES.

Camphor Liniment.

87. *Camphor,* . . . . 1 *ounce.*
Olive or Cotton-seed Oil, . . . 4 *ounces.*

Crush the camphor and set it aside in the oil till it is dissolved.

Soap Liniment (Opodeldoc).

88. *Hard Soap,* . . . . 2½ *ounces.*
Camphor, ... 1¼ „
Oil of Rosemary, . . . 3 *fluid drachms.*
Rectified Spirit, . . . 18 *fluid ounces.*
Water, ... 2 „ „

Crush the soap and camphor and mix with the spirit and water, finally add the oil of rosemary.

Soap and Opium Liniment.

89. *Liniment of Soap,* . . } *of each* 1 *ounce.*
Tincture of Opium, . . }
(*Laudanum*). }

This is also frequently called opodeldoc. It is useful as a stimulating liniment for sprains, bruises, stiff joints, &c., *after all pain has ceased.* Sprinkled on flannel and applied to the throat it is useful in sore throat, hoarseness, and for the relief of cough. For sprains 1 tea-spoonful tincture of arnica may be added.

Ammonia and Camphor Liniment.

90. *Ammonia Water* (*Spirit of Hartshorn*), ... 1 *tea-spoonful.*
Liniment of Camphor, . . 1 *ounce.*

The above liniment is useful as a stimulant, for friction to the chest, stiff joints, rheumatic joints, &c.

Turpentine Liniment.

91. *Oil of Turpentine,* . . . . . 4 *ounces.*
Camphor, ... ¼ *ounce.*
Soft Soap, ... ½ „

Mix. This is employed as a stimulating liniment in cases mentioned under No. 90, and 3 ounces of it mixed with 5 of camphor liniment are used as a liniment for the chest in cases of chronic bronchitis, pain in the chest, and for sore-throat, hoarseness, &c.

Chilblain Liniment (Wardrop's).

92. *Tincture of Cantharides* (*Spanish-fly*), ... 3 *drachms.*
Soap Liniment, ... 9 „

Soothing Liniment.

93. *Liniment of Aconite*, . .
Liniment of Belladonna, } *of each* 1 *ounce.*
Liniment of Chloroform,

Mix. This is a very soothing mixture for rubbing on painful joints, rheumatic joints, for neuralgia, for pain in the back or side. (See p. 919.)

The liniments of aconite and belladonna are made by taking 20 ounces of the aconite or belladonna root, bruising and rubbing it into a coarse powder, and letting it steep for several days in rectified spirit, during which the mixture is frequently shaken up. Then the liquid portion is drained off, and the refuse washed with spirit. The total quantity obtained should be 20 fluid ounces. Finally an ounce of camphor is added.

The liniment of chloroform is made with two fluid ounces of chloroform, and two of liniment of camphor (No. 87).

Liniment of Lime (Carron-oil).

94. *Lime Water*, ... 1 *ounce.*
Olive, Linseed, or Cotton-seed Oil, 1 „

Mix. This is a most soothing application to burns (p. 999).

The lime-water is made with 1 ounce slaked lime, and 80 ounces (4 pints or ½ gallon) distilled water. Keep it in a stoppered bottle, and draw off the clear solution as required. The lime is slaked as follows: take 1 ounce fresh lime, add 1 fluid ounce boiling water and then 30 ounces cold water, and stir occasionally for half an hour. Allow it to stand an hour, carefully pour off the water. The white deposit remaining is the slaked lime. Lime-water may be straightway made from it by adding 30 ounces distilled water, stirring the mixture well for a time, then allowing the coarser particles to settle, and pouring off the watery portion into a stoppered bottle, where it stands till clear. The clear water is then used as required.

Lotions for Wounds.

95. These have been sufficiently indicated on p. 917 and p. 971.

Eye Lotions.

Chamomile-tea Wash.

96. *Chamomile Flowers*, . ½ *ounce.*
Boiling Water, . . . 10 *ounces* (½ *pint*).

Infuse for half an hour and strain.

This is a very mild eye wash. It may be diluted with lukewarm water for use. If a stronger solution is required, as when the eyes are mattering, one of the following three may be substituted:—

97. *Sulphate of Zinc*, ... 2 *grains.*
Water, ... 1 *ounce.*

Or,

98. *Alum*, ... 2 *grains.*
Water, ... 1 *ounce.*

Or,

99. *Bichloride of Mercury*, . . . 1 *grain.*
Water, ... 2 *ounces.*

Dissolve. This is still further diluted for use with two or three times the quantity of water.

Note.—*It is very poisonous, and must be kept out of the range of being accidentally used for internal medicine.*

Any of these four may be used as a wash for inflamed conditions of the eyelids. (Refer to *Conjunctivitis*, p. 368). When there is fear of light to any extent, and the eye cannot be opened to the light, such should not be used, but the atropine drops employed and the other treatment recommended under inflammation of the cornea (p. 371).

Eye Ointment.

100. *Yellow Precipitate*, ... 8 *grains.*
Vaseline or Lard, ... 1 *ounce.*

Mix with the aid of heat. A stronger ointment with the same ingredients is mentioned on p. 367.

101. *Weak Citrin Ointment*, . . . 1 *drachm.*
Vaseline or Lard, ... 7 *drachms.*

Mix. This is very suitable for applying to the edges of inflamed and thickened eyelids with inflammation round the lashes (see p. 367).

Hair Wash.

102. *Aromatic Spirit of Ammonia*, . . 1 *ounce.*
Spirit of Rosemary, ... 1 „
Glycerine, ... 1 „
Tincture of Cantharides (Spanish-fly), ... ½ „
Rose Water, ... *to* 8 *ounces.*

Mix. This is to be applied to the roots of the hair with a piece of sponge or a fine brush, when the hair is falling off.

Erasmus Wilson's Hair Wash.

103. *Strong Liquor Ammonia*, . . 1 *ounce.*
Spirit of Rosemary, ... 3 *ounces.*
Tincture of Cantharides, . . . 1 *ounce.*
Almond Oil, ... 1 „
Lavender Water, ... 2 *ounces.*

Use as directed for No. 102.

GLOSSARY.

Abdomen (Lat. *abdere*, to conceal), the belly, pp. 130, 138.

Abortion (Lat. *abortio*), a miscarriage, p. 513.

Abrasion (Lat. *ab*, off, and *rado*, I rub), removal of the protecting surface of the skin, p. 974.

Abscess (Lat. *abscedere*, to separate), a collection of matter, pp. 28, 209.

Absorption (Lat. *absorbere*, to suck up), the process by which materials are taken up by vessels in the body, pp. 201, 204.

Acetabulum (Lat. *acetum*, vinegar) means a vessel for holding vinegar. Applied to the socket into which the upper end of the thigh-bone fits to form the hip-joint, p. 22.

Acholia (Gr. *a*, not, and *cholē*, bile), absence of bile, p. 199.

Acromion (Gr. *akros*, high, and *omos*, the shoulder), the process of the shoulder blade which forms the point of the shoulder, p. 21.

Acute (Lat. *acutus*, sharp), applied to disease running a rapid course with severe symptoms, p. 4.

Adenitis (Gr. *adēn*, a gland), inflammation of glands, p. 207.

Adenoid (Gr. *adēn*, a gland), gland-like, p. 201.

Adipose (Lat. *adeps*, fat), applied to fatty tissue, p. 17.

Aeroscope (Gr. *aēr*, the air, and *skopeō*, I examine), an instrument for determining the presence of particles in the air, p. 685.

Ætiology (Gr. *aitia*, a cause, and *logos*, a discourse), the branch of medical science which deals with the causes of disease, p. 4.

Afferent (Lat. *ad*, to, and *fero*, I carry), nerves or vessels which convey impressions or blood or lymph towards the centre of the body, p. 291.

Agraphia (Gr. *a*, not, and *graphō*, I write), loss of power of writing, p. 120.

Albumin (Lat. *album*, white), a substance of which white of egg is a type, p. 132.

Albuminuria (Lat. *albumin*, from *album*, white, and Gr. *ouron*, the urine), albumin in the urine, p. 295.

Algide (Lat. *algeo*, to be very cold), applied to a stage of cholera, p. 188.

Alkalies (Arabic, *al*, essence, and *kali*, the plant from which soda was first obtained), compounds of certain metals, soda, potash, &c., which neutralize acids, p. 844.

Alkaloid (*alkali*, which see, and Gr. *eidos*, likeness), certain complex nitrogenous principles found in plants, such as morphia, strychnia.

Alopecia (Gr. *alopex*, a fox, in which partial loss of hair is common), loss of hair, p. 329.

Alteratives (Lat. *alter*, another), remedies which modify nutritive processes in the body, p. 822.

Alveolus, pl. **Alveoli** (Lat. *alveus*, a trough), applied to the sockets of the teeth and the air-cells of the lung, p. 252.

Amaurosis (Gr. *amauroō*, I darken), loss of sight, partial or complete, p. 378.

Amblyopia (Gr. *amblus*, dulled, and *ōps*, eye), defective vision, p. 378.

Amenorrhœa (Gr. *a*, absence of, *mēn*, the month, *reō*, I flow), absence of the monthly illness, p. 508.

Amnesia (Gr. *amnēsia*, forgetfulness), loss of memory of words, p. 120.

Amnion (Gr.), the membranous sac enclosing the fœtus, p. 485.

Amœba (Gr. *ameibō*, I change), an elementary organism, p. 214.

Ampulla (Lat. *ampulla*, a flask), a dilated portion of a canal, p. 358.

Amyloid (Lat. *amylum*, starch), starch-like, p. 200.

Anæmia (Gr. *a*, without, and *haima*, blood), the condition of poverty of blood, pp. 103, 215.

Anæsthesia (Gr. *a*, not, and *aisthanomai*, I perceive), loss of feeling, p. 118.

Anæsthetics (see above), substances which abolish sensation, p. 904.

Anasarca (Gr. *ana*, through, and *sarx*, flesh), a term for dropsy, p. 435.

Anatomy (Gr. *ana*, apart, and *temnō*, I cut), the science which deals with the structure of organized bodies, p. 15.

Anchyloblepharon (Gr. *ankulē*, a thong, and *blepharon*, the eyelid), adhesion of eyelids to one another, p. 369.

Anchylosis (Gr. *ankulos*, curved), the stiffening and fixing of a joint by disease, p. 33.

Aneurism (Gr. *aneurunō*, to widen), a tumour formed by dilatation of an artery, p. 244.

Angeioma (Gr. *angeion*, a blood-vessel), a blood-vessel tumour, p. 247.

Angina (Lat. *angina*, from *ango*, I strangle), an affection of the heart accompanied by a paroxysm of pain, p. 243.

Angioleucitis (Gr. *angeion*, a vessel, *leukos*, white, and termination *itis*), inflammation of lymphatic vessels, p. 206.

Anodynes (Gr. *a*, without, and *odunē*, pain), remedies for the relief of pain, p. 897.

Anorexia (Gr. *an*, negative, and *orexis*, appetite), want of appetite, p. 146.

Anosmia (Gr. *a*, not, and *osmē*, smell), loss of sense of smell, p. 366.

Antacids (Gr. *anti*, against, and Lat. *acidus*, acid), remedies which neutralize acids, pp. 839, 843.

Anthelmintic (Gr. *anti*, against, and *elmins*, a worm), remedies against worms, p. 871.

Anthrax (Gr. *anthrax*, a coal or carbuncle), an infectious disease specially attacking animals, but communicable to man, p. 315.

Anthropometry (Gr. *anthrōpos*, a man, and *metron*, a measure), the measurements of the physical proportions of the body, strength, weight, height, &c., p. 467.

Antidote (Gr. *anti*, against, and *didōmi*, to give in return), a medicine which counteracts the effects of a poison or destroys it, p. 1018.

Antifebrile (Gr. *anti*, against, and Lat. *febris*, fever), applied to remedies for fever, p. 820.

Antiperiodic (Gr. *anti*, against, and *periodos*, a period), remedies for diseases which have increase or return at regular intervals, such as ague, p. 823.

Antiphlogistic (Gr. *anti*, against, and *phlōgōsis*, heat), a remedy for fever, p. 820.

Antipyretic (Gr. *anti*, against, and *puretos*, fever), remedies for fever, p. 819.

Antiseptic (Gr. *anti*, against, and *sēpō*, I make putrid), substances which prevent putrefaction, p. 395.

Antispasmodics (Gr. *anti*, against, *spasmos*, a spasm), remedies to allay spasm of pain, flatulence, &c., p. 897.

Anus (Lat. *anus*, the sitting thing), the termination of the bowel, p. 130.

Aorta (Gr. *aeirō*, I take up or carry), the large artery springing from the left side of the heart, p. 219.

Aperients (Lat. *aperio*, I open), medicines which gently open the bowels, p. 856.

Aphasia (Gr. *a*, not, and *phēmi*, I speak), a disease of the brain causing loss of the faculty of speech, p. 94.

Aphemia (Gr. *a*, not, and *phēmi*, I speak), loss of faculty of speech, p. 120.

Aphonia (Gr. *a*, not, *phōnē*, the voice), loss of voice, p. 287.

Aphthæ (Gr. *aphtha*, from *aptō*, I set on fire), the patches of thrush, p. 149.

Apnœa (Gr. *a*, not, *pneō*, I breathe), temporary arrest of breathing through saturation of the blood with oxygen, p. 286.

Aponeuroses, fibrous membranes inclosing muscles, p. 73.

Arachnoid (Gr. *arachnē*, a spider's web, and *eidos*, shape), a membrane of brain and spinal cord, pp. 91, 97.

Argyria (Gr. *arguros*, silver), discoloration of the skin due to prolonged use of silver as an internal remedy.

Arthritis (Gr. *arthron*, a joint), inflammation of a joint, p. 33.

Articulation (Lat. *articulus*, a joint), a joint, p. 23.

Arytenoid (Gr. *arutaina*, a pitcher), cartilages of the box of the windpipe, p. 262.

Ascaris (Lat. *ascaris*, a worm), a round-worm, p. 173.

Ascites (Gr. *askitēs*, from *askos*, a bag), dropsy of the belly, p. 191.

Asphyxia (Gr. *asphuxia*, a stopping of the pulse), suffocation, pp. 285, 1008.

Asthenopia (Gr. *a*, not, *sthenos*, strength, *ōps*, the eye), weak-sightedness, p. 378.

Astigmatism (Gr. *a*, want of, and *stigma*, a point), a defect of the eye, causing blurred vision, p. 378.

Astragalus (Gr. *astragalos*), the bone of the ankle on which the lower leg bones rest, p. 23.

Atavism (Lat. *atavus*, a grandfather), the inheritance of some peculiarity existing in a grandparent, but absent from the parent, p. 7.

Atelectasis (Gr. *atelēs*, imperfect, and *ektasis*, widening), imperfect expansion of the lungs after birth, p. 283.

Atheroma (Gr. *athara*, gruel), a disease of arteries, p. 244.

Atonic (Gr. *a*, not, and *tonos*, tone), without tone or power.

Auditory (Lat. *audio*, I hear), belonging to the organ or sense of hearing, p. 357.

Auricle (Lat. *auricula*, a little ear), the upper chamber of each side of the heart, p. 219. The outer part of the ear, p. 356.

Auscultation (Lat. *ausculto*, I listen), a method of examining the body by listening over various parts, p. 266.

Axilla (Lat.), the arm-pit, p. 227.

B.

Bacillus (Lat. *bacillum*, a little rod), a variety of germ, pp. 387, 393.

Bacteria (Gr. *baktērion*, a little staff), a variety of germ, p. 386.

Basilic (Gr. *basilikos*, royal), applied to veins of the arm from the notion that they were of great importance to the body, p. 229.

Biceps (Lat. *bis*, twice, and *caput*, the head), applied to muscles, p. 72.

Bicuspid Teeth (Lat. *bis*, twice, and *cuspis*, a point), applied to teeth, pp. 136, 137.

Bleb (Saxon *blædr*, from *blasan*, to blow), a watery sac or vesicle, p. 313.

Blepharitis (Gr. *blepharon*, the eyelid, and *itis*, signifying inflammation), inflammation of the edge of the eyelid, p. 367.

Bothriocephalus latus (Gr. *bothrion*, a little pit, and *kephalē*, the head, Lat. *latus*, broad), a tape-worm, pp. 168, 170.

Brachial (Lat. *brachium*, the arm), belonging to the arm, p. 99.

Bromism, symptoms due to continued use of the bromides, p. 905.

Bronchiectasis (Gr. *bronchia*, bronchial tubes, and *ektasis*, widening), dilatation of bronchial tubes, p. 272.

Bronchitis (Gr. *bronchos*, and *itis*, signifying inflammation), inflammation of bronchial tubes, p. 270.

Bronchocele (Gr. *bronchos*, the windpipe, and *kēlē*, tumour), goitre, p. 210.

Bronchus (Gr. *bronchos*), applied to the two divisions of the windpipe, p. 251.

Bubo (Gr. *boubōn*, the groin), an inflammation of a lymphatic gland, usually of the groin, pp. 987, 988.

Bulimia (Gr. *bou*, indicating emphasis, and *limos*), morbid hunger, p. 146.

Bulla (Lat. *bulla*, a bubble of water), a bleb, p. 313.

Bursæ (Gr. *bursa*, a bag or purse), applied to small sacs, secreting fluid, placed over a joint or tendon to facilitate its movement and prevent friction, p. 75.

C.

Cachexia (Gr. *kakos*, bad, and *hexis*, a habit), a morbid condition of body, p. 4.

Cæcum (Lat. *cæcus*, blind), the beginning of the large intestine, p. 130.

Calcaneus (Lat. *calcaneum*, from *calx*, the heel), the bone of the heel, p. 83.

Calcareous (Lat. *calx*, lime), chalky, pp. 243, 923.

Calculus (Lat. *calculus*, a small stone, from *calx*, chalk), applied to any concretion formed in the body, p. 298.

Callus (Lat. *callus*, hardness), the material formed round the ends of a broken bone to knit them together, p. 36.

Calorie (Lat. *calor*, heat), the unit of heat, p. 529.

Calorimeter (Lat. *calor*, heat, and Gr. *metron*, a measure), an instrument for measuring amount of heat given off from a body.

Canaliculi (Lat. *canaliculus*, a small channel), small canals in bone, p. 18.

Cancellated (Lat. *cancelli*, lattice), applied to spongy bone because of the lattice-like arrangement of the bone spicules, p. 17.

Canities (Lat. *canities*, hoariness, from *canus*, gray-haired), grayness of hair, p. 329.

Capelline (from Lat. *caput*, the head), applied to a bandage for the head, p. 960.

Capillaries (Lat. *capillus*, a hair), the finest subdivisions of the blood-vessels, p. 225.

Carbo-hydrates (Lat. *carbo*, a coal, and Gr. *hudōr*, water), compounds of carbon with hydrogen and oxygen in proportions to form water, such as sugar and starches, p. 133.

Carbonaceous (Lat. *carbo*), of the nature of carbon, applied to sugary and starchy food-stuffs, p. 538.

Carcinoma (Gr. *karkinos*, a crab), a variety of cancer, p. 433.

Cardiac (Gr. *kardia*, the heart), belonging to the heart.

Caries (Lat. *caries*, rottenness), ulceration of bone, p. 26.

Carminatives (Lat. *carmen*, a song or charm), applied to remedies for flatulence, p. 848.

Carotid (from Gr. *karoō*, to throw into a heavy sleep), applied to the large arteries of the neck by the ancients from belief that they were the cause of deep sleep.

Carpus (Gr. *karpos*, the wrist), the wrist, p. 22.

Cartilage (Lat. *cartilago*), gristle, p. 23.

Casein (Lat. *caseus*, cheese), an albuminous body, the chief component of curd of milk, p. 132.

Caseous (Lat. *caseus*, cheese), cheesy. Frequently applied to morbid stuff found in inflamed glands.

Catalepsy (Gr. *katalambanō*, to attack), a disease in which sensation and consciousness are suspended and the body is rigid, p. 521.

Cataract (Gr. *katarassō*, I fall down), an affection of the lens of the eye causing blindness, p. 374.

Catarrh (Gr. *kata*, down, *reō*, I flow), inflammation of a mucous membrane attended by discharge, for example, cold in the head, p. 154.

Cathartic (Gr. *kathairō*, I purge), a variety of purgative medicines, p. 860.

Catheter (Gr. *kathetēr*, anything let down into), an instrument passed into the bladder to draw off water, p. 1050.

Cauda equina (Lat. *cauda*, a tail, *equinus*, belonging to a horse), the bundle of nerves passing off from the end of the spinal marrow, p. 97.

Cellular (Lat. *cellula*, a little cell), consisting of cells or cavities, p. 16.

Cellulose (deriv. same as above), a variety of starch, p. 537.

Cephalalgia (Gr. *kephalē*, the head, and *algos*, pain), pain in the head.

Cephalic (Gr. *kephalikos*, belonging to the head), applied to veins of the arm, p. 229.

Cerebellum (diminutive of Lat. *cerebrum*, the brain), the hind brain, p. 90.

Cerebritis (*cerebrum*, and terminal *itis*), inflammation of the brain, p. 101.

Cerebro-spinal (*cerebrum*, and *spina*, the spine), related to both brain and spinal cord, p. 89.

Cerebrum (Lat. *cerebrum*, the brain), the large brain, p. 89.

Cerumen (Lat. *cera*, wax), ear-wax, p. 356.

Cervical (Lat. *cervix*, the neck), related to the neck, p. 20.

Cestodes (Gr. *kestos*, a studded girdle, and *eidos*, likeness), tapeworms.

Chalazion (Gr. *chalaza*, hail), a tumour of eyelid, p. 368.

Chalybeate (Gr. *chalups*, iron), containing iron, as chalybeate waters, p. 947.

Chloasma (Gr. *chloaxō*, to be green), an affection of the skin, p. 322.

Chlorosis (Gr. *chlōros*, green), green-sickness, p. 235.

Chologogue (Gr. *cholē*, bile, and *agō*, I lead out), remedies which induce a flow of bile, p. 856.

Chorea (Gr. *choreia*, a dancing), St. Vitus' dance, p. 125.

Chronic (Gr. *kronikos*, concerning time), applied to long-standing disease, p. 4.

Chyle (Gr. *chulos*, juice), nutritive fluid absorbed from the bowel, p. 200.

Chyluria (*chyle*, and Gr. *ouron*, urine), chyle in the urine, p. 305.

Chyme (Gr. *chumos*, juice), the partially digested material which passes into the bowel from the stomach, p. 129.

Cicatrix (Lat. *cicatrix*, a scar), the scar of a healed wound, p. 968.

Cilium (plural *cilia*, Lat. *cilium*, an eyelash), applied to minute hair-like processes on cells, p. 16.

Cirrhosis (Gr. *kirros*, yellow), originally applied to a disease of the liver, now applied to thickening of connective tissue of any organ, p. 196.

Clavicle (Lat. *clavicula*, a little key), the collar-bone, p. 21.

Clonic (Gr. *klonos*, commotion), of an irregular movement, jerking.

Clysters (Gr. *kluzō*, I wash away), an injection into the bowel, p. 873.

Coccyx (Gr. *kokkux*, the cuckoo), the four rudimentary bones united together and forming the end of the backbone in man; called *os coccygis*, or bone of the cuckoo, from a supposed resemblance to the bill of the cuckoo, p. 20.

Cœliac (Gr. *koilia*, the belly), belonging to the belly.

Colloid (Gr. *kolla*, glue), a term applied by Graham to insoluble non-crystalline organic substances which cannot pass through organic membranes, such as starch, p. 134.

Colon (Gr. *kolon*, food), part of the large bowel, p. 130.

Colostrum (Lat. *colostrum*), the first milk in the breasts after delivery.

Columnæ carneæ (Lat., meaning fleshy pillars), applied to muscular projections on inner wall of heart, p. 222.

Coma (Gr. *kōma*, deep sleep), deep sleep of an unnatural kind, the person being incapable of being roused to consciousness, p. 102.

Comedones (Lat. *comedo*, a glutton), the black-pointed mattery substance that can be squeezed out of the hair-sacs of cheeks, forehead, and nose, p. 327.

Commissure (Lat. *committo*, I join together), a bond of connection.

Condyle (Gr. *kondulos*, a hard knob), a prominent part of a bone in connection with a joint, p. 23.

Congenital (Lat. *con*, together, and *genitus*, begotten), applied to any disease or malformation, &c., existing at birth, p. 3.

Conjunctiva (Lat. *con*, together, and *jungo*, I join), the membrane which lines the inner surface of the eyelids and is reflected on to the eyeball, p. 339.

Conjunctivitis (Lat. *conjunctiva*, and terminal *itis*), inflammation of the conjunctiva, p. 368.

Contagion (Lat. *con*, together, *tango*, I touch), the communication of disease by the transference from the diseased person to another of the special seed or germ of the disease by contact direct or indirect, p. 384.

Contusion (Lat. *con*, together, and *tundo*, I beat), a bruise, p. 974.

Convalescence (Lat. *convalesco*, to grow well), the stage of recovery from illness.

Coracoid (Gr. *korax*, a raven, and *eidos*, likeness), applied to a process of the shoulder-blade, from a supposed resemblance to a crow's beak.

Corium (Lat. *corium*, the skin), the true skin, p. 307.

Cornea (Lat. *cornu*, a horn), the transparent part of the front of the eyeball, p. 339.

Coronary (Lat. *corona*, a crown), applied to vessels that encircle parts. Coronary vessels of heart, p. 219.

Coronoid (Gr. *korōne*, a crow, and *eidos*, likeness), applied to processes of lower jaw (p. 22) and lower end of upper arm-bone.

Corpora Quadrigemina (Lat. *corpus*, a body, and *quadrigeminus*, fourfold), ganglia at base of brain, p. 90.

Corpora Striata (Lat. for striated bodies), ganglia at base of brain, p. 90.

Corpus Callosum (Lat. for thick-skinned body), a transverse mass of nervous substance connecting the two hemispheres of the brain, p. 89.

Corpuscle (Lat. *corpusculum*, diminutive of *corpus*, a body), small cellular bodies, as the cells of the blood, p. 213.

Coryza (from Gr. *korus*, the head), cold in the head, p. 154.

Costal (Lat. *costa*, a rib), related to the ribs, p. 256.

Cranium (Gr. *kranion*, the skull), the skull; that part of the head distinguished from the face, p. 19.

Crepitation (Lat. *crepitus*, a crackling), the feeling of grating of the two ends of a broken bone, p. 40. It is applied also to the sound heard in the lungs on listening over the chest when material is present in the lungs, as in inflammation.

Cribriform (Lat. *cribrum*, a sieve, and *forma*, shape), applied to a part of the ethmoid bone, p. 19.

Cricoid (Gr. *krikos*, a ring, and *eidos*, likeness), applied to a part of the box of the windpipe, p. 250.

Crural (Lat. *crus*, the leg), belonging to the leg, p. 192.

Cuneiform (Lat. *cuneus*, a wedge), a bone of the wrist, pp. 22, 23.

Cuticle (Lat. *cuticulus*, diminutive of *cutis*, the skin), the scarf-skin, p. 307.

Cyanosis (Gr. *kuanōsis*, a dark-blue colour), lividity, p. 244.

Cyst (Gr. *kustis*, the bladder), a sac filled with more or less fluid contents.

Cysticercus (Gr. *kustis*, the bladder, and *kerkos*, a tail), the bladder-worm, a stage in the development of tape-worm, p. 169.

Cystitis (*cyst*, and termination *itis*), inflammation of the urinary bladder, p. 305.

D.

Deglutition (Lat. *deglutio*, I swallow down), the act of swallowing, p. 143.

Dementia (Lat. *de*, negative, and *mens*, the mind), a species of insanity, p. 109.

Dental (Lat. *dens*, a tooth), belonging to a tooth, p. 137.

Dermis (Gr. *derma*, the skin), the true skin, p. 307.

Desquamation (Lat. *desquamo*, I scale off, from *de*, away, and *squama*, a scale), a scaling or peeling of the scarf-skin, p. 313.

Diabetes (Gr. *dia*, through, and *bainō*, I go on), a disease in which a large quantity of urine containing sugar is passed, p. 147.

Diagnosis (Gr. *dia*, between, and *gnōsis*, knowledge), the determining a disease by means of the observation of symptoms, &c., p. 8.

Diaphoretics (Gr. *diaphoreō*, to carry across), drugs which increase the amount of sweat, p. 887.

Diaphragm (Gr. *diaphragma*, a partition), the tendinous and muscular partition between chest and belly, p. 253.

Diarrhœa (Gr. *dia*, through, and *reō*, I run), the disease characterized by very frequent fluid motions, p. 184.

Diastase (Gr. *diastasis*), a ferment formed in grain during germination, p. 666.

Diastasis (Gr. *diastasis*, a separation), applied to the separation of the ends from the shaft of growing bone, p. 35.

Diastole (Gr. *diastellō*, I open) applied to the dilatation of the cavities of the heart, p. 224.

Diathesis (Gr. *diathesis*, a placing in order, a state or condition), a condition of body rendering it liable to certain special diseases; for example, a gouty diathesis, p. 7.

Digastric (Gr. *dis*, double, and *gastēr*, the belly), two-bellied; applied to a muscle, p. 70.

Digit (Lat. *digitus*, a finger), a finger or toe. *Digital*, belonging to fingers or toes.

Diploë (Gr. *diploē*, a fold), the spongy bone between the outer and inner tables of bone making the thickness of the skull bone.

Diplopia (Gr. *diploos*, double, and *opsis*, sight), double sight, seeing double, p. 379.

Dipolar (Gr. *dis*, double, and *polŏs*, the axis of a globe), two-poled; applied to nerve-cells, p. 85.

Dipsomania (Gr. *dipsa*, thirst, and *mania*, madness), the unconquerable craving for drink, p. 105.

Disinfection (Lat. *dis*, negative, and *inficio*, I corrupt), the destruction of infective material, p. 395.

Diuretics (Gr. *dia*, through, and *oureō*, I pass water), drugs which increase the flow of urine, p. 890.

Dorsal (Lat. *dorsum*, the back), belonging to the back, pp. 20, 99.

Drastic (Gr. *drastikos*, active, from *draō*, I do), applied to vigorous purgative medicines, p. 861.

Duodenum (Lat. *duodeni*, twelve apiece), the first part of the small intestine, about 12 inches long.

Dura Mater (Lat., meaning hard mother), applied to the external membrane investing brain and spinal cord; old idea being that it gave origin to all other membranes of the body, and it is of tough quality, p. 91.

Dysmenorrhœa (Gr. *dus*, difficulty, *mēn*, a month, and *reō*, I flow), painful monthly illness, p. 510.

Dyspareunia (Gr. *duspareunos*, ill-mated), difficult or painful performance of the sexual function, p. 519.

Dysphagia (Gr. *dus*, and *phagein*, to eat), difficulty of swallowing, p. 157.

Dysphonia (Gr. *dus*, and *phonē*, the voice), imperfect voice, p. 287.

Dyspnœa (Gr. *dus*, and *pneō*, I breathe), difficulty of breathing, p. 284.

E.

Ecchymosis (Gr. *ek*, out, and *cheō*, I pour), an effusion of blood into the skin or tissue beneath it, producing the well-known discoloration of a bruise, p. 974.

Ectropion (Gr. *ektrepō*, to divert), applied to the turning outwards of the inner surface of the eyelid, p. 367.

Eczema (Gr. *ekzema*, something thrown out by heat, from *ekzeō*, I boil over), a skin disease, p. 318.

Efferent (Lat. *e* or *ex*, out, and *fero*, I carry), outgoing; applied to vessels or nerves carrying material or impressions from the centre to the circumference of the body, p. 87.

Effleurage (French, *effleurer*, to touch lightly), a variety of stroke in massage, p. 772.

Efflorescence (Lat. *effloresco*, I flourish), a flowering; applied in medicine to the rash of fevers.

Embolism (Gr. *emballō*, I throw in), applied to the obstruction of a blood-vessel by something carried to it in the blood stream. The obstructing thing is called an *embolus*, p. 102.

Embrocation (Gr. *embrechō*, I soak in), a fluid for external application to a part.

Embryo (Gr. *embruon*, from *em*, in, and *bruō*, I swell with), the rudiment of a living thing; applied to the growing offspring before the fourth month of pregnancy, p. 485.

Emetic (Gr. *emeō*, I vomit), applied to substances which induce vomiting, p. 850.

Emphysema (Gr. *emphusēma*, an inflation), applied to an over-distended condition of air-cells of the lungs, p. 271.

Emprosthotonus (Gr. *emprosthen*, forwards, and *teinō*, I stretch), a condition in which, by spasmodic contraction of muscles, the body is bent forwards, p. 126.

Empyema (Gr. *em*, within, and *puon*, pus, matter), a collection of matter in the chest cavity, p. 267.

Emunctory (Lat. *emungo*, I blow the nose), applied to organs or channels by which effete matter is removed from the body.

Encephaloid (Gr. *encephalos*, the brain, *eidos*, likeness), brain-like, p. 434.

Encephalon (Gr. *en*, in, and *kephalē*, the head), the parts within the skull, p. 89.

Endemic (Gr. *en*, in, and *dēmos*, a people), applied to a disease peculiar to a people or neighbourhood from some cause special to it, p. 4.

Endocarditis (Gr. *endon*, within, *kardia*, the heart, and terminal *itis*), inflammation of the inner lining membrane of the heart, p. 239.

Endocardium (same deriv. as above), the inner lining membrane of the heart, p. 220.

Endolymph (Gr. *endon*, within, and Lat. *lympha*, water), applied to fluid in canals of inner ear, p. 358.

Endosmosis (Gr. *endon*, and *ōsmos*, a pushing in), the process by which a substance in solution passes to the inner side of an organic membrane, p. 134.

Endosteum (Gr. *endon*, and *osteon*, a bone), the lining membrane of the marrow cavity of a bone, p. 18.

Endostitis (same deriv. as above, with terminal *itis*), inflammation of endosteum, p. 27.

Enema (Gr. *enema*, from *eniēmi*, to inject), an injection, p. 873.

Enteric (Gr. *enteron*, the bowel), belonging to the bowels. See enteric fever, p. 411.

Enteritis (same deriv. as *enteric*, with terminal *itis*), inflammation of bowel, p. 162.

Entropion (Gr. *en*, in, and *trepō*, I turn), a turning in of the eyelid, p. 367.

Epidemic (Gr. *epi*, upon, *dēmos*, a people), applied to disease prevalent among a people, and due to a special cause not commonly present, p. 4.

Epidermis (Gr. *epi*, upon, and *derma*, the skin), the scarf-skin, p. 307.

Epigastrium (Gr. *epi*, upon, and *gastēr*, the stomach), the region of the belly over the stomach, the epigastric region, p. 131.

Epiglottis (Gr. *epi*, upon, and *glottis*, the upper opening of the windpipe), the structure that acts as a lid to the windpipe, p. 136.

Epiphyses (Gr. *epi*, upon, and *phuō*, I grow), applied to the ends of a long bone, which in development become ossified apart from the shaft, p. 18.

Epispastics (Gr. *epi*, upon, and *spaō*, I draw), remedies which blister, p. 914.

Epistaxis (Gr. *epi*, upon, and *stazō*, I let fall in drops), bleeding from the nostrils, p. 366.

Epithelioma (Gr. *epi*, upon, and *thēlē*, the nipple), skin cancer, p. 434.

Epithelium (Gr. *epi*, upon, and *thēlē*, a nipple), the layer or layers of cells forming the surface layer of skin or mucous membrane, p. 16.

Eructation (Lat. *eructo*, I belch), a belching of wind from the stomach.

Erythema (Gr. *eruthainō*, I make to blush), a slight inflammation, redness of skin, p. 313.

Ethmoid (Gr. *ēthmos*, a sieve, and *eidos*, likeness), a bone of the skull, p. 19.

Exanthemata (Gr. *exanthēma*, an eruption), infectious fevers attended by rash, p. 397.

Excoriation (Lat. *ex*, out of, and *corium*, the skin), an abrasion.

Excreta (Lat. *excerno*, I sift out), effete material removed from the body.

Exophthalmia (Gr. *ex*, out, and *ophthalmos*, the eye), protrusion of the eyeball.

Exostosis (Gr. *ex*, out, and *osteon*, a bone), a bony outgrowth from bone due to disease, p. 27.

Expectorant (Lat. *ex*, out of, and *pectus*, the breast), remedies which promote the expulsion of material from lungs and air-passages, p. 879.

Expectoration (Lat. *ex*, out of, and *pectus*, the breast), spitting out material from mouth, throat, lungs, &c., and also the material so expelled.

Extravasation (Lat. *extra*, outside of, and *vasa*, vessels), the pouring out among the tissues from a cavity or vessel of its fluid contents, p. 974.

Exudation (Lat. *ex*, out, and *sudo*, I sweat), oozing of fluid through the walls of the vessel or receptacle which contains it; also the material which exudes, p. 248.

F.

Fæces (Lat. *fæx*, sediment), motions from the bowel.

Farinaceous (Lat. *farina*, flour), applied to starchy food-stuffs, p. 584.

Fascia (Lat. *fascia*, a band), applied to the fibrous tissue investing muscles, &c., p. 67.

Fauces (Lat. for the upper part of the throat), the cavity at the back of the mouth, p. 136.

Febrifuge (Lat. *febris*, fever, and *fugo*, I drive away), applied to remedies for fever, p. 820.

Femoral (Lat. *femur*, the thigh), belonging to the thigh, p. 228.

Femur (Lat. for the thigh), the thigh-bone, p. 23.

Fibula (Lat. *fibula*, a brooch), the clasp-bone, the outer bone of the foreleg, p. 23.

Fission (Lat. *fissio*, a dividing), the process of cleavage in cell reproduction, p. 387.

Fistula (Lat. *fistula*, a tube), an unnatural channel leading from the outside of the body inwards, p. 500.

Flatulence (Lat. *flatus*, a breath), wind in stomach or bowels.

Fluctuation (Lat. *fluctus*, a wave), the wave-like feeling communicated to the fingers when a cavity containing fluid is smartly tapped, p. 32.

Fœtus (Lat. *fœtus*, offspring), applied to the child in the womb in the later months, p. 485.

Furunculus (Lat.), a boil, p. 365.

G.

Ganglion, pl. **Ganglia** (Gr. *ganglion*, a tumour under the skin), an enlargement in the course of a nerve, containing nerve-cells as well as nerve-fibres, pp. 78, 85.

Gangrene (Gr. *grainō*, I gnaw), death of tissue in mass, p. 248.

Gastralgia (Gr. *gastēr*, stomach, and *algos*, pain), pain at the region of the stomach. Same as gastrodynia.

Gastric (Gr. *gastēr*, the stomach), related to the stomach.

Gastritis (Gr. *gastēr*, and terminal *itis*), inflammation of the stomach, p. 157.

Gastrocnemius (Gr. *gastēr*, the belly, and *knēmē*, the leg), the muscle of the calf of the leg, p. 74.

Gastrodynia (Gr. *gastēr*, and *odunē*, pain), pain in the stomach, p. 181.

Gastro-enteritis (Gr. *gastēr*, and *enteron*, the bowel), inflammation of both stomach and bowel.

Genu-valgum (Gr. *gonu*, the knee, and Lat. *valgus*, having the legs bent outwards), knock-knee, p. 83.

Gland (Lat. *glans*, an acorn), an organ for manufacturing some material for the blood for subsequent use in the body or for removal from the body, or which takes part in blood formation, p. 201, 204.

Glaucoma (Gr. *glaukos*, denoting a greenish-yellow colour), a disease of the eye causing blindness, p. 375.

Glenoid (Gr. *glēnē*, the pupil or eyeball, and *eidos*, likeness), applied to a depression in one bone to receive the head of another, p. 21.

Glomerulus (Lat., diminutive of *glomus*, a small ball), applied to the tufted arrangement of vessels in the kidney, p. 290.

Glosso-pharyngeal (Gr. *glossa*, the tongue, and *pharunx*, the throat), connected with tongue and throat, applied to one of the cranial nerves, p. 90.

Glottis (Gr. *glottis*, the upper opening of the windpipe), the opening in the box of the windpipe between the vocal cords, p. 262.

Gluteus (Gr. *gloutos*, the buttock), belonging to the buttock; applied to muscles, nerves, and vessels, p. 73.

Glycogen (Gr. *glukus*, sweet, and *gennaō*, I produce), animal starch, p. 147.

Glycosuria (Gr. *glukus*, sweet, and *ouron*, urine), sugar in urine, p. 303.

Granulation (Lat. *granum*, a grain), applied to the small bright grain-like fleshy elevations that appear on a healing wound; also to the process by which open wounds heal.

Gumma, pl. **Gummata** (Lat. *gumma*, gum), small tumours that occur in various tissues as a consequence of syphilis, p. 424.

Gustatory (Lat. *gusto*, I taste), relating to taste, as gustatory nerve, the nerve of taste, p. 337.

H.

Hæmatemesis (Gr. *haima*, blood, and *emeō*, I vomit), vomiting of blood, p. 159.

Hæmatinuria (Gr. *hæmatin*, the colouring matter of blood, and *ouron*, urine), passage of urine containing the colouring matter of blood, p. 304.

Hæmaturia (Gr. *haima*, blood, and *ouron*, urine), blood in the urine, p. 304.

Hæmophilia (Gr. *haima*, blood, and *philia*, fondness for), a disposition to bleeding, p. 238.

Hæmoptysis (Gr. *haima*, and *ptusis*, spitting), blood-spitting, the blood being from the lungs, p. 282.

Hæmorrhage (Gr. *haima*, and *rēgnumi*, I break forth), escape of blood from the vessels.

Hæmorrhoids (Gr. *haima*, and *reō*, I flow), piles, p. 193.

Hemeralopia (Gr. *hēmera*, the day, and *ōps*, the eye), blindness, except in daylight, p. 378.

Hemiopia (Gr. *hemisus*, half, and *ōps*, the eye), a condition in which only one half of an eye has perception of things.

Hemiplegia (Gr. *hemisus*, half, and *plēgē*, a stroke), paralysis of motion on one side of the body, p. 118.

Hepatic (Gr. *hēpar*, the liver), belonging to the liver.

Hepatitis (Gr. *hēpar*, the liver, and *itis*), inflammation of the liver, p. 196.

Hirsuties (Lat. *hirsutus*, hairy), an unnatural development of hair, p. 329.

Hordeolum (Lat. *hordeolus*, diminutive of *hordeum*, barley), a sty in the eye, p. 368.

Humerus (Lat.), the upper arm bone, p. 21.

Hyaline (Gr. *hualos*, glass), transparent like glass. See hyaline cartilage, p. 24.

Hybernation (Lat. *hibernus*, belonging to winter), the dormant state into which certain animals and plants fall with a low temperature, p. 113.

Hydatid (Gr. *hudatis*, a watery sac), a stage in the development of tape-worm, p. 172.

Hydragogue (Gr. *hudōr*, water, and *agō*, I lead out), remedies which cause a watery discharge from the bowels.

Hydrocele (*hudōr*, and *kēlē*, a tumour), a tumour with watery contents connected with external generative organs.

Hydrocephalus (Gr. *hudōr*, water, and *kephalē*, the head), water in the head, p. 101.

Hydrometer (Gr. *hudōr*, and *metron*, a measure), an instrument for determining specific gravity of watery fluids.

Hydronephrosis (Gr. *hudōr*, and *nephros*, the kidney), dropsy of the kidney, p. 299.

Hydropericardium (Gr. *hudōr*, water, *peri*, about, and *kardia*, the heart), dropsy of the heart, p. 435.

Hydrothorax (Gr. *hudōr*, and *thorax*, the chest), dropsy of the chest.

Hygiene (Gr. *hugieinos*, good for the health), the science of the laws of health, p. 522.

Hygroscopic (Gr. *hugros*, moist, and *skopeō*, I look at), having the property of absorbing moisture.

Hyoid (Gr. *huoeidēs*, shaped like the Greek letter upsilon), applied to the bone at the root of the tongue, p. 250.

Hyperæmia (Gr. *huper*, in excess, and *haima*, blood), an excess of blood in a part, p. 235.

Hyperæsthesia (Gr. *huper*, and *aisthēsis*, a feeling), oversensibility, p. 364.

Hypermetropia (Gr. *huper*, *metron*, a measure, and *ōps*, the eye), longsightedness.

Hypertrophy (Gr. *huper*, and *trophē*, nourishment), overgrowth, p. 76.

Hypnotics (Gr. *hupnos*, sleep), drugs which procure sleep, p. 904.

Hypochondriasis (*hupochondriakos*, one affected in hypochondriac region), a form of melancholy in which the person believes himself to be suffering now from one disease, now from another. The cause of the disease was of old referred to the hypochondriac region.

Hypochondrium (Gr. *hupo*, under, and *chondros*, gristle, under the gristly part of the ribs), the regions of the body on the right and left side below the ribs.

Hypodermic (Gr. *hupo*, under, and *derma*, the skin), put under the skin.

Hypogastric (Gr. *hupo*, and *gastēr*, the stomach), referring to the region below that where the stomach is placed, p. 131.

Hypoglossal (Gr. *hupo*, and *glōssa*, the tongue), beneath the tongue, p. 90.

I.

Ichthyosis (Gr. *ichthus*, fish), fish-skin disease, p. 320.

Icterus (Gr. *ikteros*, jaundice), yellowness of skin due to jaundice, p. 198.

Ileo-cæcal (Gr. *eileō*, I turn about, Lat. *cæcum*, blind), applied to the junction between the ileum, end of the small bowel, and cæcum, head of the large bowel, p. 130.

Ileum (Gr. *eileō*, I turn about), applied to the small bowel from its windings, p. 130.

Iliacus (Lat. *ilia*, the flanks), applied to a muscle in the hollow of the ilium, p. 73.

Ilium (Lat. *ilia*, the flanks), part of the bone of the haunch, p. 22.

Impetigo (Lat. *impetigo*, a scabby eruption of the skin), a pustular disease of the skin, p. 319.

Incisor (Lat. *incido*, I cut), applied to the cutting teeth, p. 136.

Incubation (Lat. *incubo*, to sit on eggs), applied in medicine to the period between the introduction of the germs of a disease into the body and the time of first appearance of its symptoms, during which period the disease is being hatched, p. 397.

Infundibulum (Lat. *infundibulum*, a funnel, from *infundo*, I pour in), applied to the passage from which the air-cells of the lungs open, p. 252.

Infusoria (Lat. *infundo*, I pour in), applied to minute organisms first observed in infusions of organic substances, p. 385.

Inguinal (Lat. *inguen*, the groin), belonging to the groin, p. 192.

Inhibitory (Lat. *inhibitus*, a restraining), applied to the restraining influence of one nervous action over another, p. 233.

Innominate (Lat. *in*, negative, and *nomen*, a name), The unnamed bone, haunch-bone, p. 22.

Inoculation (Lat. *inoculo*, I ingraft), the introduction into the body by a wound of the skin of the poison of some disease, p. 405.

Insalivation (Lat. *in*, in, and *saliva*, the spittle), the process of mixing the food with saliva in the mouth, p. 142.

Insolatio (Lat. *insolo*, I place in the sun), sunstroke, p. 1003.

Insomnia (Lat. *in*, negative, and *somnus*, sleep), sleeplessness, p. 116.

Intercostal (Lat. *inter*, between, and *costa*, a rib), applied to structures between the ribs, p. 255.

Intermittent (Lat. *intermitto*, I leave off for a time), applied to diseases which disappear and return again after a variable time, p. 427.

Interossei (Lat. *inter*, and *os*, a bone), situated between bones. See interossei muscles, p. 73.

Intussusception (Lat. *intus*, within, and *suscipio*, I receive), applied to the passage of a part of the bowel within another part, p. 164.

Inunction (Lat. *inungo*, I anoint), the rubbing of an oily substance into the skin, p. 824.

Invagination (Lat. *in*, in, and *vagina*, a sheath), same as intussusception, p. 165.

Iodism, symptoms produced by the taking of iodine in too large or long-continued doses, p. 1020.

Iridectomy (Gr. *iris*, a rainbow, and *ektemnō*, I cut out), an operation for removing a portion of the coloured ring of the eyeball to improve sight, p. 372.

Iritis (Gr. *iris*, and terminal *itis*), inflammation of the iris of the eye, p. 373.

Ischium (Gr. *ischion*, the seat-bone), the seat-bone, p. 22.

J.

Jejunum (Lat. *jejunus*, empty), applied to a portion of the small bowel, believed to be generally found empty after death, p. 130.

Jugular (Lat. *jugulum*, the throat), belonging to the throat, p. 228.

K.

Keratitis (Gr. *keras*, a horn, and terminal *itis*), inflammation of the cornea of the eye, p. 371.

L.

Lachrymal (Lat. *lachryma*, a tear), relating to tears, such as the tear-gland, p. 339.

Lacteal (Lat. *lac*, milk), applied to vessels because of the milky juice contained, p. 145.

Lactometer (Lat. *lac*, and Gr. *metron*, a measure), an instrument for gauging quality of milk, p. 551.

Lacuna (Lat. *lacuna*, a cavity), cavities in bone occupied by bone cells, p. 18.

Lardaceous (Lat. *lardum*, the fat of bacon), applied to a certain form of tissue degeneration, p. 200.

Laryngismus (Gr. *larungizō*, I vociferate), an affection of the box of the windpipe, so called from the peculiar sound of the cry produced in it, p. 273.

Laryngitis (Gr. *larunx*, the upper part of the windpipe, and *itis*), inflammation of the box of the windpipe, p. 269.

Laryngoscope (*larynx*, and Gr. *skopeō*, I look at), an arrangement of mirrors for viewing the larynx, p. 263.

Laryngotomy (*larynx*, and Gr. *temnō*, I cut), the operation of opening the box of the windpipe from outside, p. 262.

Latissimus (Lat. for "very broad"), applied to a muscle of the back, p. 71.

Laxative (Lat. *laxo*, I loosen), opening medicines, p. 856.

Leucocytes (Gr. *leukos*, white, and *kutos*, a cell), white-cells, p. 213.

Leucocythæmia (Gr. *leukos*, *kutos*, and *haima*, the blood), white-celled blood, p. 235.

Leucorrhœa (Gr. *leukos*, and *roia*, a flow), white discharge from the female genital organs, p. 499.

Leukæmia (Gr. *leukos*, white, and *haima*, the blood), same as leucocythæmia, p. 235.

Lientery (Gr. *leios*, smooth, and *enteron*, the bowel), a species of diarrhœa, p. 185.

Ligament (Lat. *ligo*, a tie), a connecting band, p. 23.

Locomotor ataxia (Lat. *locus*, a place, and *moto*, I move, Gr. *a*, wanting, and *taxis*, order), a nervous disease characterized by unsteadiness of gait, p. 121.

Lumbar (Lat. *lumbi*, the loins), applied to the region of the loins, p. 28.

Lymphadenoma (Lat. *lympha*, water, and Gr. *adēnē*, a gland), a disease affecting lymphatic glands and producing great pallor, p. 210.

Lymphangitis (Lat. *lympha*, Gr. *angeion*, a vessel, and terminal *itis*), inflammation of lymphatic vessels, p. 206.

Lymphoma (same as *Lymphadenoma*).

Lysis (Gr. *luo*, I dissolve), the gradual decline of fever as distinct from crisis, p. 397.

M.

Malar (Lat. *mala*, the cheek-bone, from *mando*, I chew), belonging to the cheek-bone, p. 19.

Malaria (Lat. *malus*, bad, *aer*, air), the atmosphere of fever-producing marshy districts.

Malleolus (Lat. *malleus*, a hammer), projections of the lower leg-bones at the ankle, p. 23.

Masseter muscles (Gr. *massaomai*, I chew), applied to muscle of the jaw, p. 70.

Mastication (same deriv. as *masseter*), the act of chewing, p. 142.

Mastoid (Gr. *mastos*, a nipple, and *eidos*, likeness), applied to a nipple-shaped process of the temporal bone, p. 19.

Maxillary (Lat. *maxilla*, a jaw), belonging to the jaw, p. 19.

Medulla (Lat. *medulla*, marrow, for *medius*, middle), the marrow of bone (p.17), or spinal marrow (p. 96).

Medullitis, inflammation of the medulla, p. 27.

Melæna (Gr. *melas*, black), black motions, due to the presence of blood, p. 166.

Meninges (Gr. *mēninx*, a membrane), applied to membranes of brain, p. 91.

Meningitis, inflammation of membranes of brain, p. 100.

Menorrhagia Gr. *mēn*, a month, and *rēgnumi*, I burst forth), excessive monthly flow, p. 509.

Menses (Lat. *mensis*, a month), the monthly discharge, p. 481.

Menstruation (Gr. *mēn*, a month, and *reō*, I flow), the process of the monthly illness, p. 481.

Mesentery (Gr. *mesos*, middle, and *enteron*, intestine), a membrane connected with the intestine, pp. 131, 191. *Mesenteric*, belonging to the mesentery.

Metacarpal (Gr. *meta*, beyond, and *carpus*, the wrist), applied to the bones between the wrist and finger bones, the bones of the palm, p. 22.

Metatarsal (Gr. *meta*, beyond, and *tarsos*, the instep), applied to the bones between ankle and toes, p. 23.

Metrorrhagia (Gr. *mētra*, the womb, and *rēgnumi*, I burst forth), a discharge of blood from the womb at other than the monthly periods, p. 509.

Microbe (Gr. *micros*, small, and *bios*, life), same as micro-organism.

Micro-coccus (Gr. *mikros*, and *kokkos*, a berry), a form of germ, p. 387.

Micro-organisms (Gr. *mikros*), small living organisms, p. 387.

Microphytes (Gr. *mikros*, small, and *phutos*, a plant), the same meaning as micro-organisms, p. 387.

Microzymes (Gr. *mikros*, and *zumē*, yeast), applied to minute organisms, because they cause fermentation, p. 387.

Molars (Lat. *mola*, a mill), grinding teeth, p. 136.

Monomania (Gr. *monos*, single, and *mania*, madness), that form of insanity in which the aberration is in regard to one subject only, p. 108.

Morphinomania (*morphia* and *mania*), the craving for morphia, p. 1026.

Multipolar (Lat. *multus*, many, and *polos*, an axis), applied to cells with many processes, p. 85.

Myelitis (Gr. *muelos*, marrow, and terminal *itis*, inflammation), inflammation of the spinal cord, p. 117.

Myopia (Gr. *muō*, I shut or blink, and *ōps*, the eye), short-sightedness, p. 347.

N.

Nævus (Lat. *nævus*, a spot), a mother's mark, p. 247.

Narcotics (Gr. *narka*, deep sleep), p. 904.

Nausea (Gr. *nausia*, sickness, from *naus*, a ship, in relation to sea-sickness), a feeling of sickness, p. 12.

Necrosis (Gr. *nekros*, dead), death of bone, p. 26.

Nematode (Gr. *nema*, a thread, and *eidos*, likeness), a round-worm, p. 167.

Nephritis (Gr. *nephros*, the kidney, and *itis*), inflammation of the kidney, p. 295.

Neurilemma (Gr. *neuron*, a nerve, and *lemma*, a skin), the connective tissue investment of nerve-fibres, p. 85.

Neuritis (Gr. *neuron*, and *itis*), inflammation of a nerve.

Neuroglia (Gr. *neuron*, a nerve, and *glia*, glue), the connective tissue ground-substance of nervous tissue, p. 91.

Neuroma (Gr. *neuron*, a nerve), a nerve tumour.

Neurosis (deriv. as above), a nervous affection without discoverable structural change or material cause. A functional disorder.

Nyctalopia (Gr. *nux*, night, *alaos*, blind, and *ōps*, the eye), night blindness.

Nystagmus (Gr. *nustazō*, I nod), an involuntarily rolling motion of the eye-ball, p. 376.

O.

Obturator (Lat. *obturo*, to stop up), applied to an opening in the pelvis, and to muscles, vessels, and nerves passing through it.

Occipital (Lat. *occiput*, the back of the head), p. 19.

Odontoid (Gr. *odous*, a tooth, and *eidos*, likeness), applied to a process of the second cervical vertebra, p. 21.

Œdema (Gr. *oideō*, I swell), dropsy of the cellular tissue, p. 435.

Œsophagus (Gr. *oisō*, I bear, and *phagein*, to eat), the gullet, p. 157.

Olecranon (Gr. *ōlenē*, the ulna, and *kranon*, head), applied to a process of the head of the ulna, one of the fore-arm bones, p. 22.

Olfactory (Lat. *oleo*, I smell, and *facio*, I make), related to the sense of smell, p. 90.

Onychia (Gr. *onuz*, the nail), inflammation of the nail, p. 330.

Ophthalmia (Gr. *ophthalmos*, the eye), applied to certain inflammations of the eye, p. 368.

Ophthalmoscope (Gr. *ophthalmos*, the eye, and *skopeō*, I view), an instrument for examining the interior of the eye, p. 376.

Opiate (Gr. *opion*, from *opos*, a vegetable juice), a drug containing opium, or one which induces sleep, p. 897.

Opisthotonus (Gr. *opisthen*, backwards, and *teinō*, I draw), a state of spasm in which the body is bent backwards like a bow, pp. 126, 1028.

Os calcis (Lat. for the bone of the heel, *calx*, the heel), p. 23.

Os coccyx (Lat. for the coccyx bone). See Coccyx.

Os magnum (Lat. for large bone), a bone of the wrist, p. 22.

Os sacrum (Lat. for sacred bone, because it was formerly offered in sacrifice), a part of the backbone, p. 22.

Ossification (Lat. *os*, a bone, and *facio*, I make), the process of bone formation, p. 18.

Osteomalachia (Gr. *osteon*, a bone, *malakos*, soft), softening of bone, p. 31.

Osteomyelitis (Gr. *osteon*, a bone, and *muelos*, marrow), inflammation of the marrow of bone, p. 25.

Ostitis (Gr. *osteon*, a bone, and *itis*, signifying inflammation), inflammation of bone, p. 25.

Otitis (Gr. *ous*, the ear, and *itis*), inflammation of the ear.

Otoliths (Gr. *ous*, the ear, and *lithos*, a stone), small bony bodies found in the inner ear of some animals, p. 358.

Oxidation (Gr. *oxus*, acid), the process of uniting with oxygen, p. 527.

Oxyuris (Gr. *oxus*, sharp, and *ouron*, a tail), applied to a genus of thread-worms, p. 174.

Ozæna (Gr. *ozē*, a foul smell), stink-nose, p. 365.

P.

Paræsthesia (Gr. *para*, implying irregularity, and *aisthēsis*, sensation), a disorder of sensation. See p. 364.

Paraplegia (Gr. *para*, incompletely, and *plēssō*, I strike), paralysis of the lower limbs, p. 119.

Paresis (Gr. *pariēmi*, I relax), a slight degree of paralysis, p. 118.

Parietal (Lat. *paries*, a wall), applied to bones situated on the side of the head, p. 19.

Parotid (Gr. *para*, near, and *ous*, the ear), applied to a salivary gland in the neighbourhood of the ear, p. 137.

Parotitis, inflammation of the parotid gland—mumps, p. 153.

Patella (Lat. *patella*, a dish), the knee-pan, p. 23.

Pathology (Gr. *pathos*, suffering, and *logos*, discourse), the science which treats of the nature, cause, &c., of disease, p. 54.

Pectoralis (Lat. *pectus*, the breast), related to the breast, p. 71.

Pediculus (Lat. diminutive of *pedis*, a louse), a louse, p. 324.

Pelvis (Lat. *pelvis*, a basin), the cavity formed by the haunch-bones, p. 20.

Pemphigus (Gr. *pemphix*, a bladder), a disease of the skin, p. 317.

Percussion (Lat. *percutio*, I strike), a method of examining the body by striking with the finger or an instrument made for the purpose, to note the kind of sound elicited, p. 266.

Pericarditis, inflammation of pericardium, p. 238.

Pericardium (Gr. *peri*, about, and *kardia*, heart), the membranous investment of the heart, p. 219.

Perilymph Gr. *peri*, around, and *lympha*, water), the fluid within the bony labyrinth of the inner ear, p. 358.

Perinæum (Gr. *peri*, about, and *naiō*, to be situated), the part of the body between the genital organs in front and the opening of the bowel behind.

Periosteum (Gr. *peri*, about, and *osteon*, a bone), the outer lining membrane of bone, p. 17.

Periostitis, inflammation of periosteum, p. 25.

Peristaltic (Gr. *peristellō*, I involve), applied to the vermicular or worm-like movement of the bowel, p. 183.

Peritoneum (Gr. *peri*, about, *teinō*, I stretch), the delicate membrane investing the inner surface of the abdomen, p. 130.

Peritonitis, inflammation of peritoneum, p. 190.

Perityphlitis (Gr. *peri*, around, and *tuphlon*, the

head of the large bowel), inflammation of the connective tissue around the cæcum—the head of the large bowel, p. 163.

Pertussis (Lat. *per*, signifying excess, and *tussis*, a cough), whooping-cough.

Petechiæ (Italian, *petecchies*, flea-bites), small purple spots on the skin like flea-bites, p. 237, 240, 427.

Petrissage (French, meaning kneading), a term used in massage, p. 772.

Phalanges (plural of *phalanx*, Greek for a line of soldiers), applied to the bones of fingers and toes.

Pharynx (Gr.), the cavity at the upper end of the gullet, into which the mouth opens, p. 138.

Phlebitis (Gr. *phleps*, a vein, and *itis*), inflammation of veins, p. 246.

Phlyctenæ (Gr. *phluxein*, to be hot), applied to small vesicles on the eyeball, p. 369.

Phrenic (Gr. *phrēn*, the diaphragm), applied to the nerve and vessels of the diaphragm, p. 99.

Phthiriasis (Gr. *phtheir*, a louse), lousiness, p. 324.

Phthisis (Gr. *phthinomai*, I waste), consumption, p. 277.

Physiology (Gr. *phusis*, nature, and *logos*, a discourse), the science which treats of the functions of living things, p. 15.

Pisiform (Lat. *pisum*, a pea, and *forma*, shape), a bone of the wrist, p. 22.

Pityriasis (Gr. *pituron*, bran), a skin disease, accompanied by scurfiness, p. 319.

Plethora (Gr. *plēthō*, I fill), full-bloodedness, p. 235.

Pleura (Gr. *pleuron*, a rib), the membrane lining the inner surface of the chest walls and investing the lungs, p. 253.

Pleurisy, inflammation of the pleura, p. 266.

Pleuritis, same as pleurisy.

Pleuro-pneumonia (Gr. *pleura*, a rib, and *pneumōn*, the lung), an associated inflammation of lungs and pleura, p. 275.

Plexus (Lat., meaning a network), applied to a network of vessels or nerves, p. 99.

Pneumogastric (Gr. *pneumōn*, a lung, and *gastēr*, the belly), a nerve arising within the brain, and distributed to lungs, heart, stomach, &c., p. 96.

Pneumonia (Gr. *pneumōn*, the lung), inflammation of the lung), p. 274.

Pneumothorax (Gr. *pneuma*, air, *thōrax*, the chest), a collection of gas in the chest cavity, p. 269.

Podagra (Gr. *pous*, the foot, and *agra*, a seizure), gout, p. 432.

Polypus (Gr. *polus*, many, and *pous*, a foot), a variety of growth springing from a mucous membrane, p. 381.

Polyuria (Gr. *polus*, much, *ouron*, urine), applied to disease characterized by excess of urine, p. 302.

Pons Varolii (Lat. *pons*, a bridge, and *Varolius*, the name of an anatomist), a transverse mass of fibres connected with the cerebellum, p. 90.

Popliteal (Lat. *poples*, the ham), pertaining to the ham, p. 228.

Presbyopia (Gr. *presbus*, an old man, and *ōps*, the eye), impairment of power of accommodating the eye for near objects, common to age, p. 378.

Prognosis (Gr. *pro*, *gnōsis*, a knowing), the opinion as to the future course of a disease from a consideration of its nature, symptoms, &c., p. 13.

Prolapse (Lat. *pro*, forwards, and *lapsus*, a falling), a variety of displacement of an organ, p. 194.

Pronation (Lat. *pronus*, with face downward), the motion which turns the palm of the hand downward, p. 22.

Prophylactic (Gr. *pro*, before, and *phulassō*, I guard), employed in connection with the prevention of disease, p. 14.

Proteids (Gr. *prōtos*, first), applied to albuminous food-stuffs, p. 132.

Protoplasm (Gr. *prōtos*, first, and *plasma*, formed material), applied to the simplest form of living material, p. 15.

Pruritis (Lat., meaning an itching), a variety of perverted sensation, characterized by itching, pp. 323, 497.

Psoas (Gr. *psoa*), belonging to the loin, as psoas muscle, p, 73.

Psoriasis (Gr. *psoō*, I rub), a scaly disease of the skin, p. 877.

Pterygoid (Gr. *pterux*, a wing, and *eidos*, likeness), applied to bones of the head, and muscles connected with them, p. 70.

Ptomaines (Gr. *ptōma*, a dead body), active principles of the nature of alkaloids—derived from bodies in a state of decay, pp. 599, 1014.

Ptosis (Gr. *ptōsis*, a fall), a drooping of the eyelid, p. 369.

Ptyalism (Gr. *ptualon*, saliva), excessive secretion of saliva, p. 150.

Pubis (Lat. *pubis*, puberty), the front portion of the haunch-bone.

Puerperal (Lat. *puerpera*, a lying-in woman, from *puer*, a boy, and *pario*, I bear), pertaining to childbirth, p. 837.

Pulmonary (Lat. *pulmo*, a lung), belonging to the lung, p. 230.

Purgatives (Lat. *purgo*, I cleanse, and *ago*, I act), remedies which freely act upon the bowels, p. 855.

Purpura (Lat., meaning purple), a disease in which effusions of blood take place into the skin, p. 237.

Pus (Gr. *puon*, matter), matter produced in inflammation, p. 968.

Pyæmia (Gr. *puon*, pus, and *haima*, the blood), a condition of blood-poisoning, p. 236.

Pyelitis (Gr. *puelos*, a vessel, *itis*), an inflammation of a part of the kidney, p. 298.

Pylorus (Gr. *pulōros*, a gatekeeper), the part of the stomach where junction is made with the intestine, p. 130.

Pyrosis (Gr. *puroō*, I burn), waterbrash, p. 181.

Q.

Quartan (Lat. *quartus*, the fourth), a form of ague in which the attack returns after an intermission of two days, p. 428.

Quotidian (Lat. *quotidie*, daily), a form of ague in which the attack returns daily at the same hour, p. 428.

R.

Rabies (Lat. *rabies*, rage or madness), canine madness, p. 421.

Racemose (Lat. *racemus*, a cluster of grapes), applied to a form of gland structure, p. 137.

Radius (Lat. *radius*, a ray or spoke of a wheel), applied to the outer bone of the forearm, p. 22.

Ranula (Lat. *ranula*, diminutive of *rana*, a frog), a cystic tumour of the mouth, p. 150.

Rectum (Lat. *rectus*, straight), the straight part (the end) of the bowel, p. 130.

Rete mucosum (Lat. *rete*, a net), applied to the deep layer of the scarf-skin, p. 307.

Rubefacient (Lat. *rubrum*, red, and *facio*, I make), applications which redden the skin, p. 914.

Rubella (diminutive of *rubeola*), p. 402.

Rubeola (Lat. *ruber*, red), measles, p. 400.

S.

Saccharoses (Lat. *saccharum*, sugar), the chemical term applied to a variety of sugars, p. 587.

Sacral, related to *os sacrum*, which see.

Saphenous (Gr. *saphēnēs*, manifest), applied to a superficial vein and nerve of the leg, p. 229.

Sarcinæ (Lat. *sarcina*, a pack or bundle), a genus of microscopic fungi, so called from its appearance, p. 162.

Sarcolemma (Gr. *sarx*, flesh, and *lemma*, a skin), the connective tissue sheath of muscular fibres, p. 68.

Sarcous (Gr. *sarx*, flesh), applied to certain elements of muscular fibres, p. 68.

Sartorius (Lat. *sartor*, a tailor), applied to a muscle, p. 74.

Scabies (Lat. *scabies*, a scab), the itch, p. 323.

Scaphoid (Gr. *skaphē*, a skiff or boat, and *eidos*, shape), a bone of the foot, p. 22.

Scapula (Gr. *skapanē*, a spade), the shoulder-blade, p. 21.

Schneiderian, applied to the lining membrane of the nostrils, so called from Schneider, who first described it, p. 338.

Sciatic (Gr. *ischion*, the hip), applied to nerves, vessels, &c., p. 99.

Sciatica, neuralgia in the district of the sciatic nerve, p. 128.

Scirrhus (Gr. *skirros*, a hard tumour), a form of cancer, p. 434.

Sclerosis (Gr. *sklēros*, hard), a state of hardening of connective tissue, p. 118.

Sclerostoma (Gr. *sklēros*, hard, and *stoma*, the mouth), applied to a genus of parasitic worms, p. 175.

Scolex (Gr. *skōlēx*, a worm), a stage in the development of tapeworm, p. 168.

Scorbutus, scurvy, p. 237.

Scultetus, a form of bandage, p. 959.

Sebaceous (Lat. *sebum*, suet), applied to glands secreting an oily substance, connected with hair-sacs, p. 308.

Seborrhœa (Lat. *sebum*, fat, and Gr. *reō*, I flow), excess of fatty secretion of the skin, p. 327.

Sedatives (Lat. *sedo*, I ease), applied to soothing remedies, p. 897.

Septicæmia (Gr. *sēptikos*, putrid, and *haima*, the blood), blood-poisoning, p. 236.

Sequestrum (Lat. *sequestro*, I sever), a portion of dead bone, p. 26.

Serratus (Lat. *serra*, a saw), applied to a muscle, p. 71.

Serum (Lat. *serum*, akin to Gr. *oros*, whey), the fluid of blood, less its fibrinous element, p. 216.

Sigmoid (Gr. *sigma*, a letter of the Greek alphabet, and *eidos*, likeness), applied to a bend of the large bowel, p. 130.

Sinus (Lat. *sinus*, a hollow), a channel leading from an abscess to the surface, p. 261.

Soleus (Lat. *solea*, a sandal), applied to a muscle of the calf of the leg, p. 74.

Soporific (Lat. *sopor*, sleep, and *facio*, I make), remedies which induce sleep, p. 904.

Sordes (Lat. *sordes*, filth), crusts which form on lips and teeth in persons in exhaustion from disease, p. 519.

Spermatozoa (Gr. *sperma*, seed, and *zōon*, an animal), the active constituents in the male element in conception, p. 484.

Sphenoid (Gr. *sphēn*, a wedge, and *eidos*, shape), a bone of the cranium, p. 19.

Sphincter (Gr. *sphingō*, I bind), applied to circular muscles which close outlets, p. 130.

Spica (Lat. *spica*, an ear of corn), a variety of bandage so called from a supposed resemblance to the rows of an ear of corn, p. 958.

Spina bifida (Lat. *spina*, the spine, and *bifida*, cleft), a malformation of the spine, p. 457.

Spirillum (Lat. diminutive of *spira*, a curl), a variety of micro-organisms, p. 388.

Spirometer (Lat. *spiro*, I breathe, and Gr. *metron*, a measure), an instrument for measuring quantity of air expelled from the chest, p. 256.

Splanchnic (Gr. *splanchna*, the bowel), applied to nerves, &c., p. 99.

Sporadic (Gr. *speirō*, to scatter), applied to infectious disease occurring in scattered cases, not as an epidemic, p. 4.

Squamous (Lat. *squama*, a scale), scaly, p. 16.

Staphyloma (Gr. *staphulē*, a bunch of grapes), a protrusion of the coats of the eyeball, p. 372.

Stasis (Gr. *staō*, I stop), a local stagnation of blood, p. 248.

Sternum, Lat. for breast-bone, p. 21.

Stertorous (Lat. *sterto*, I snore), having a snoring sound, p. 11.

Stethoscope (Gr. *stēthos*, the breast, and *skopeō*, I examine), the instrument used for listening to the sounds of the heart and breathing, p. 266.

Strabismus (Gr. *strabōs*, twisted), squint, p. 376.

Strobilus (Gr. *strobilos*, a pine cone), applied to the adult tapeworm, p. 168.

Strophulus (Gr. *strophos*, a twisting of the bowels, colic), an eruption on the skin of infants, referred to derangement of bowels, p. 319.

Struma, same as scrofula, p. 431.

Styptics (Gr. *stuphō*, I constringe), remedies applied externally to stop bleeding, p. 919.

Subacute (Lat. *sub*, under, and *acutus*, sharp), applied to disease not quite severe enough to be called acute, p. 4.

Sublingual (Lat. *sub*, under, and *lingua*, the tongue), applied to glands, vessels, &c., situated beneath the tongue, p. 137.

Submaxillary (Lat. *sub*, under, and *maxilla*, the jaw), applied to glands and other structures lying under cover of the jaw-bone, p. 137.

Sucroses, a chemical term for a variety of sugars, p. 587.

Sudamina (Lat. *sudor*, sweat), minute vesicles produced in the skin by excessive sweating, p. 328.

Sudorifics (Lat. *sudor*, sweat, and *facio*, I make), remedies which increase sweating, p. 887.

Sudoriparous (Lat. *sudor*, sweat, and *pario*, I produce), applied to sweat glands, p. 307.

Supination (Lat. *supino*, to bend back), the motion by which the palm of the hand is directed upwards, p. 22.

Suppository (Lat. *suppono*, I place below), a conical mass of material containing some drug to be pushed up into the bowel, p. 1051.

Suppuration (Lat. *suppuro*, to generate matter), the formation of matter, p. 248.

Suture (Lat. *suo*, to sew), the junction of bones of the skull, p. 20; thread, wire, &c., by which wounds are closed, p. 970.

Symblepharon (Gr. *sun*, together, and *blepharon*, the eyelid), a condition in which the eyelids have become united, p. 369.

Symphysis (Gr. *sun*, with, and *phuō*, I grow), applied to a junction of bone, p. 22.

Syncope (Gr. *sunkopē*, a faint), fainting, pp. 243, 991.

Synechia (Gr. *sunechō*, I hold together), a disease of the eye in which the iris adheres to the cornea (anterior), or to the capsule of the crystalline lens (posterior), p. 372.

Synovia (Gr. *sun*, with, and *ōon*, an egg), a fluid poured out in joints, closed sacs, to lubricate the joint, &c., p. 23.

Synovitis (*synovia* [which see], and terminal *itis*), an inflammation of joints, p. 32.

Systole (Gr. *sustellō*, I contract), the contraction of the heart, p. 224.

T.

Tabes mesenterica (Lat. *tabes*, a consumption, and *mesenterica*, connected with the bowel), consumption of the bowel, p. 165.

Tæniæ (Gr. *tainia*, a ribbon), tapeworm, p. 168.

Talipes (Lat. *talus*, an ankle, and *pes*, a foot), club-foot, p. 82.

Tapotement (French, a *tapping*), a term in use in massage, p. 772.

Tarsus (Gr. *tarsos*, any broad flat surface), the ankle, p. 23.

Tenesmus (Gr. *teinō*, I stretch), straining at stool, p. 186.

Therapeutics (Gr. *therapeuō*, I nurse or cure), the branch of medical science dealing with the action of remedies in disease, p. 810.

Thermometer (Gr. *thermē*, heat, and *metron*, measure), an instrument for determining degree of heat, p. 9.

Thorax (Gr. *thorax*, a breastplate), the chest, p. 20.

Thrombosis (Gr. *thrombos*, a clot), clotting of blood in vessels during life, p. 246.

Thrombus (Gr. *thrombos*, a clot), the clot formed in a vessel during life, p. 216.

Thymus (Gr. *thumos*, thyme), applied to the thymus gland (p. 205), because it was compared to the flower of the plant by Galen.

Thyroid (Gr. *thureos*, a shield, and *eidos*, likeness), applied to a gland in the neck, p. 250.

Tibia (Lat. *tibia*, a pipe or flute), the large bone of the fore-leg, p. 23.

Tonsillitis, inflammation of tonsils; quinsy, p. 155.

Tonsils (Lat. *tonsilla*), glandular structures in the mouth, p. 136.

Tormina (Lat., meaning griping), griping pains in the bowels, p. 186.

Torticollis (Lat. *tortum*, twisted, and *collum*, the neck), wry-neck, p. 77.

Tourniquet (French *tourner*, to turn), instruments applied for the arrest of bleeding, p. 980.

Toxicology (Gr. *toxikon*, poison, and *logos*, a discourse), the branch of medical science which treats of poisons and their antidotes, p. 1014.

Tracheotomy (Lat. *trachea*, the windpipe, and Gr. *temnō*, I cut), the operation for opening the windpipe, p. 262.

Trapezium and **Trapezoid** (Gr. *trapezion*, a small table), bones of the wrist, p. 22.

Trapezius, applied to a muscle, p. 71.

Traumatic (Gr. *trauma*, a wound), produced by injury, as a traumatic inflammation, p. 54.

Trematode (Gr. *trēma*, a hole, a pore), a group of internal parasites, p. 168.

Triceps (Lat. *tres*, three, and *caput*, a head), applied to a muscle of the arm, p. 72.

Trichina (Gr. *thrix*, a hair), a minute nematode worm, parasitic, p. 175.

Trichinosis, the disease due to trichina, p. 175.

Trichocephalus (Gr. *thrix*, hair, and *kephalē*, the head), a genus of worms, a species of which is found in the human intestine, p. 175.

Tricuspid (Lat. *tres*, three, and *cuspis*, a point), applied to certain teeth, p. 220.

Tripolar (Lat. *tres*, three, and *polus*, an axis), applied to nerve-cells with three processes, p. 85.

Trochanters (Gr. *trochanter*, from *trochos*, anything round), prominences of the hip-bone, p. 23.

Tubercle (Lat. *tuberculum*, a little swelling), applied to certain small nodules of cells produced by morbid action in organs, p. 945.

Tuberculosis, the disease due to tubercle, p. 165.

Tympanites (same deriv. as below), distension of belly with gas.

Tympanum (Lat., meaning a drum), the drum of the ear, p. 356.

Typhlitis (Gr. *tuphlon*, the blind end of the large bowel, and *itis*, signifying inflammation), inflammation of the blind end of the large bowel, p. 163.

U.

Ulna (Gr. *ōlenē*, the elbow), the inner bone of the fore-arm, p. 22.

Umbilicus (Lat.), the navel, p. 131.

Unciform (Lat. *uncus*, a hook, and *forma*, shape), a bone of the wrist, p. 22.

Unipolar (Lat. *unus*, one, and *polus*, an axis), applied to nerve-cells with one process, p. 85.

Uræmia (Gr. *ouron*, urine, and *haima*, blood), a state of blood-poisoning. It occurs in disease of the kidney from retention in the blood of substances which ought to be expelled in the urine, p. 293, 296.

Urethritis, inflammation of the urethra (from Gr. *ouron*, urine), p. 988.

Urticaria (Lat. *urtica*, a nettle), nettlerash, p. 314.

Uterine, **Uterus** } (Lat. *uterus*, the womb), p. 479.

V.

Vaginitis, inflammation of the vaginal passage, p. 498.

Vagus (Lat., wandering), applied to a nerve from its wide distribution, p. 96.

Varicella (Lat., diminutive of *variola*, chicken-pox), p. 410.

Variola (Lat. *varius*, spotted), small-pox, p. 402.

Vascular (Lat. *vasculum*, a vessel), connected with or provided with vessels; applied to tissues containing blood-vessels, p. 835.

Vasomotor (Lat. *vasa*, vessels, and *motor*, a mover), applied to nerves controlling blood-vessels, p. 86, 233.

Venereal, applied to certain diseases connected with the sexual organs, p. 987.

Ventricles (Lat. *ventriculus*, diminutive of *venter*, the belly), a small cavity. V. of heart, p. 220, or brain, p. 91.

Vermicide (Lat. *vermis*, a worm, *cædo*, I kill), remedies which kill worms, p. 871.

Vermiform (Lat. *vermis*, a worm, and *forma*, shape), applied to a part of the large bowel, p. 130.

Vermifuge (Lat. *vermis*, a worm, and *fugo*, I drive out), remedies which expel worms, p. 871.

Vertebra (Lat. *vertebra*, a joint), applied to each of the bones forming the back-bone, p. 20.

Vertigo (Lat. *verto*, I turn), giddiness, p. 113.

Vesicant (Lat. *vesica*, a blister). Remedies which blister, p. 914.

Vibrio (Lat. *vibrio*, I shake), a variety of bacteria, p. 388.

Vomer (Lat. *vomer*, a ploughshare), the bone dividing the nasal cavity into two, p. 19.

Vulvitis, inflammation of the vulva, p. 498.

Z.

Zygoma (Gr. *zygon*, a yoke), a process of cheek-bone connecting it with the temple, p. 19.

Zymosis (Gr. *zymē*, ferment), an infectious disease, p. 4.

Zymotic, of the nature of zymosis, p. 4.

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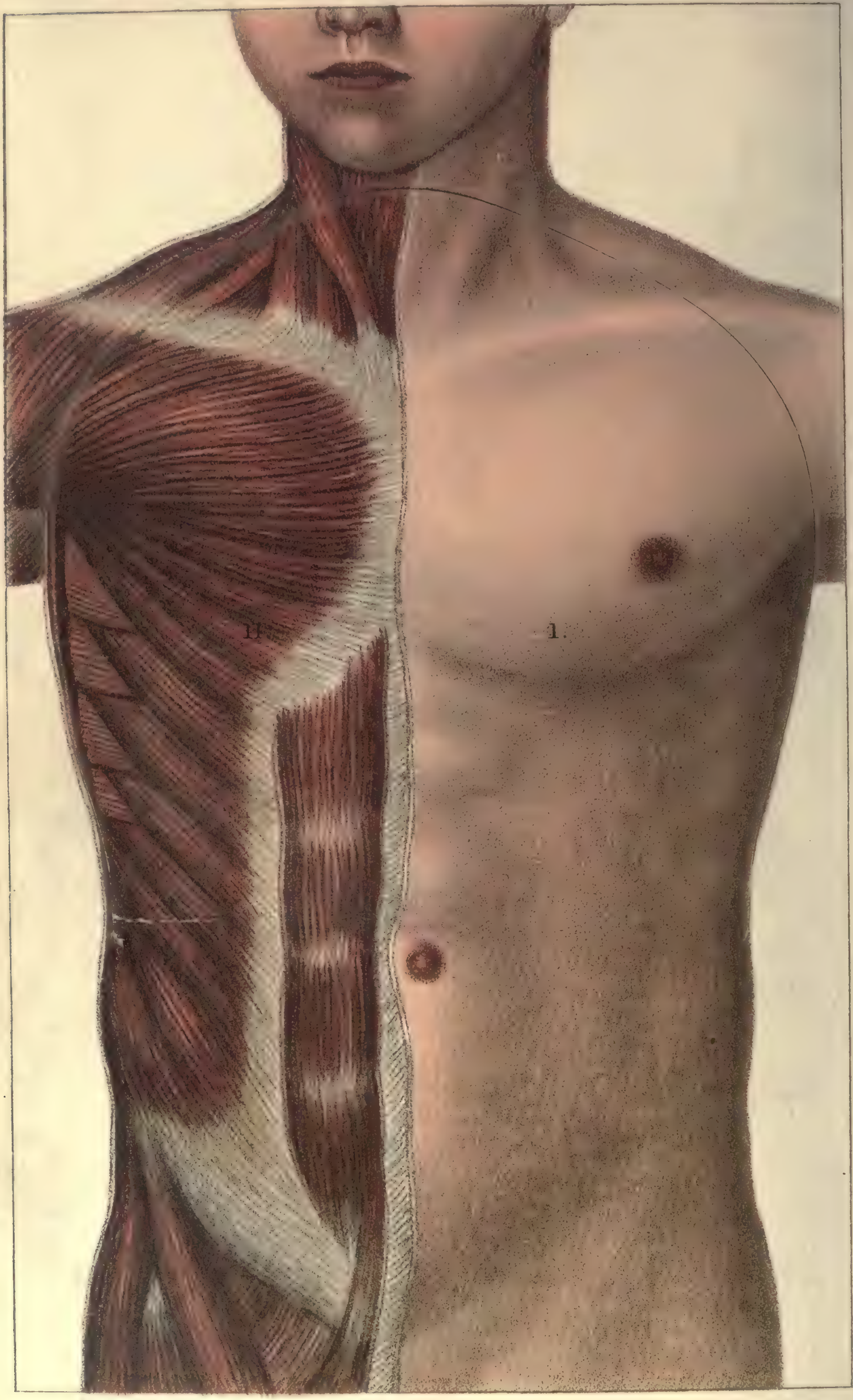
n

DISSECTION OF THE CHEST AND CONTENTS OF THE CHEST CAVITY.

Plate [illegible]



THE HUMAN BODY.

DISSECTION OF THE CHEST AND CONTENTS OF THE CHEST CAVITY.

1 represents the skin surface before dissection.

2 shows what is seen when the skin and underlying fat have been removed, namely, the great muscles of the chest wall.

3 is a representation of what is revealed when the chest wall down to the ribs and upper part of the abdominal wall have been removed. The figure is placed on the breast-bone, and the ribs and intercostal muscles are seen, as well as the contents of the upper part of the abdomen.

4 is the upper lobe of the right lung,

4A is placed on the middle lobe,

4B is placed on the lower lobe.

5 is the upper lobe of the left lung, 5A the lower lobe.

6 is placed on the left ventricle of the heart,

7 is on the left auricle of the heart.

8 is the arch of the aorta, and 9 on its branches to the head and neck.

10 is placed on the great veins going to the right side of the heart from the head and neck.

11 represents what is seen when the lung is cut into. The figure is placed near branches of the main bronchial tubes.

12 is on the diaphragm.

13 is on the liver, and 14 on the stomach.

H is on the larynx, and K on the thyroid gland.

The parts marked 1, 2, 3 speak for themselves. It will be observed that when the front wall of the chest is dissected off down to the bones, and the dissection carried so as to include the upper part of the abdominal wall, that the liver and stomach are seen to lie more or less under cover of the ribs, the liver lying mainly to the right side, but projecting beyond the middle line to the left, so that a finger pressed on the abdominal wall just at the end of the breast-bone would press on the liver.

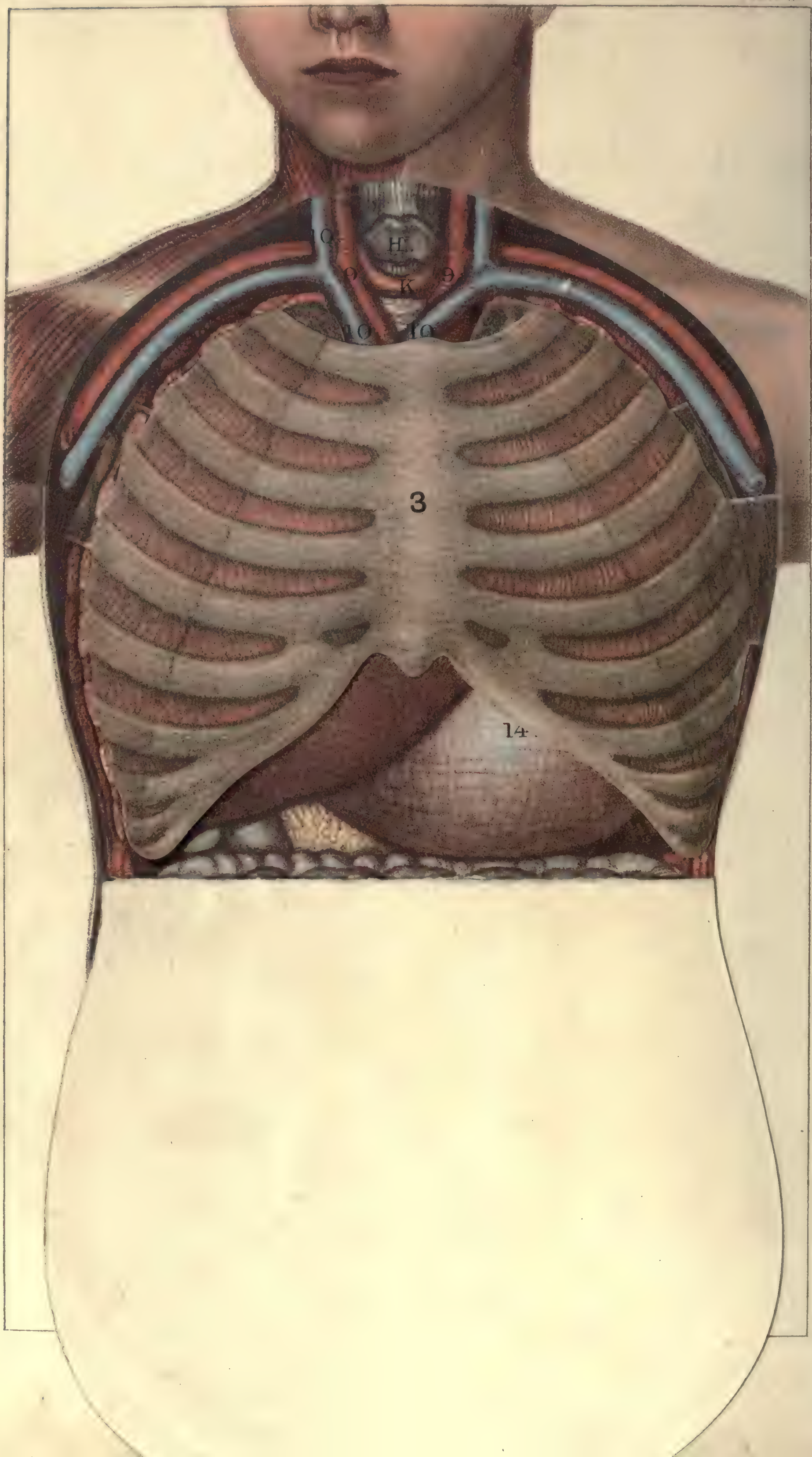
When the whole bony wall of the chest has been removed (represented by lifting the flap 3) it is seen that the lungs occupy the main portion of the chest cavity, the heart lying between, largely overlapped by the lungs, specially the left, and that the heart lies obliquely, its apex being directed to the left side. The position of the great artery arising from the heart and the great veins passing to it, and the branches of these to head and neck and upper limbs, are well shown. The plate also shows how the diaphragm separates the cavity of the chest from that of the abdomen, and how the liver and stomach lie under cover of the diaphragm. The lower part of this plate just indicates the transverse portion of the large bowel below the liver and lower border of the stomach. The plate representing the dissection of the abdomen shows this more fully.

For full information regarding the Apparatus of the Circulation, see page 218.

THE HUMAN BODY.

DISSECTION OF THE CHEST AND CONTENTS OF THE CHEST CAVITY.

Plate II



THE HUMAN BODY.

DISSECTION OF THE CHEST AND CONTENTS OF THE CHEST CAVITY.

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2 shows what is seen when the skin and underlying fat have been removed, namely, the great muscles of the chest wall.

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4 is the upper lobe of the right lung,

4A is placed on the middle lobe,

4B is placed on the lower lobe.

5 is the upper lobe of the left lung, 5A the lower lobe.

6 is placed on the left ventricle of the heart,

7 is on the left auricle of the heart.

8 is the arch of the aorta, and 9 on its branches to the head and neck.

10 is placed on the great veins going to the right side of the heart from the head and neck.

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For full information regarding the Apparatus of the Circulation, see page 218.

THE HUMAN BODY.

DISSECTION OF THE ABDOMEN AND ITS CONTENTS.

1 represents the skin of the abdomen before dissection.

2 shows the muscles of the abdominal wall when the skin and underlying fat have been dissected off.

3 The stomach. 4 The liver. 5 The curve of the first part of the small intestine—duodenum.

6, 7, 8 are on different parts of the pancreas.

9 is on the spleen.

10 is surrounded by coils of the small intestine.

11A, 11B, 11C the ascending, transverse, and descending parts of the large bowel.

11D is on the termination of the large bowel, the rectum.

12 is placed on the upper part of the bladder.

13 is on the left and 14 on the right kidney, and 15 on the ureters leading from them to the bladder.

16 is on the ascending vena cava, 17 on the descending aorta.

This plate shows that when the front wall of the abdomen has been removed the main portion of the cavity is seen to be occupied by the coils of the small intestine, the large intestine lying somewhat behind and passing up on the right side to the lower border of the liver, then bending to pass across to the left side, there again bending to pass downward towards the left groin, where it performs an S-like turn upon itself, and then continues straight to its outlet. The plate shows the liver on the upper right side of the cavity, and the greater curvature of the stomach on the upper left side, the spleen lying close to the left border of the stomach.

If the lower edge of the liver and stomach be slightly turned up, the commencement of the small intestine is seen sweeping in a curve from the narrow end of the stomach, and in the bend thus formed lies the large end of the pancreas, which, when the stomach is distended, lies behind that organ.

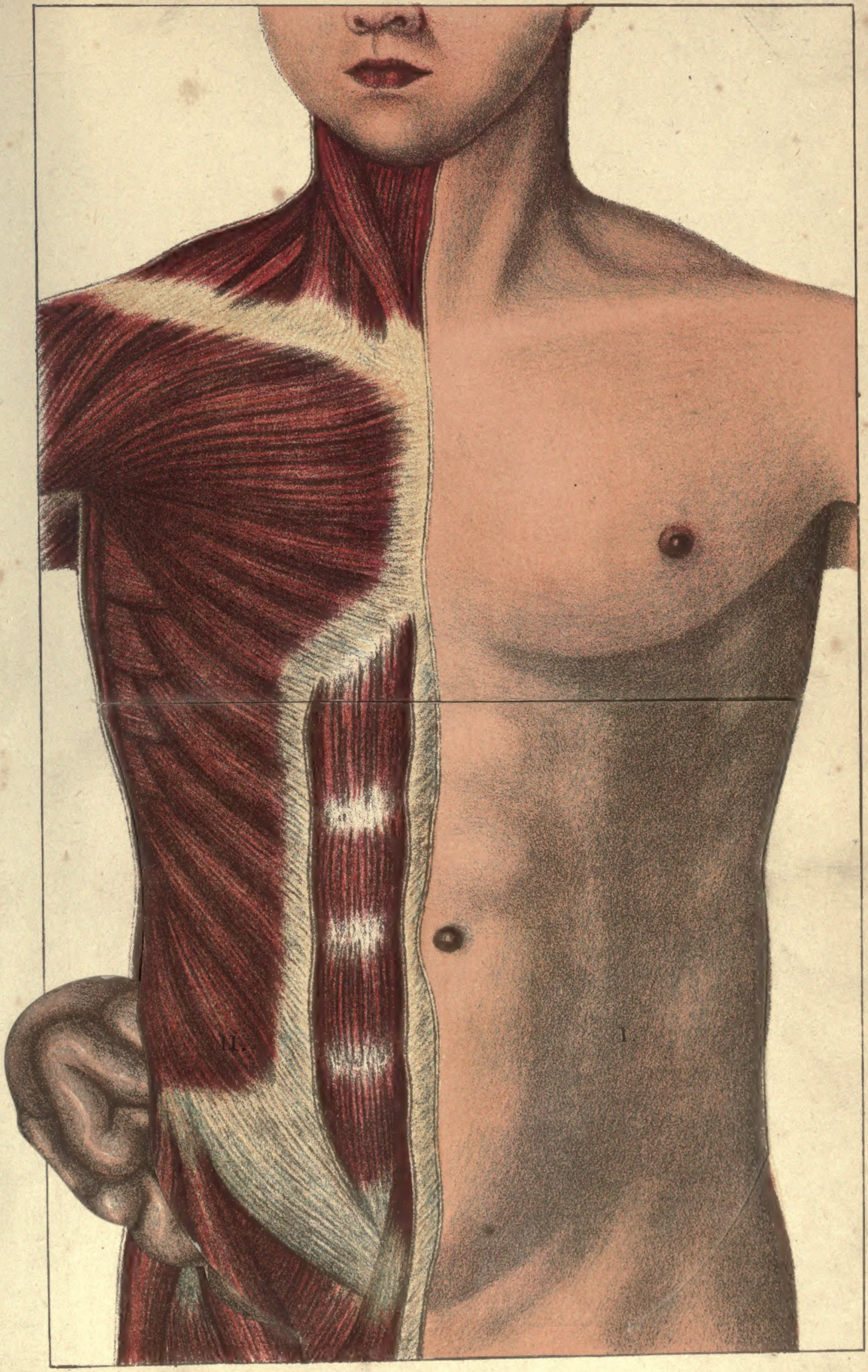
If the intestines be removed the kidneys are seen to lie close to the back wall of the cavity, and the ducts (ureters) leading from them to the bladder are shown. The bladder is represented distended, so that it peeps up above the level of the front part of the haunch bone.

For full information regarding the Digestive System, see page 129.

THE HUMAN BODY.

DISSECTION OF THE ABDOMEN AND ITS CONTENTS.

Plate XXI



THE HUMAN BODY.

DISSECTION OF THE ABDOMEN AND ITS CONTENTS.

1 represents the skin of the abdomen before dissection.

2 shows the muscles of the abdominal wall when the skin and underlying fat have been dissected off.

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THE HUMAN BODY.

DISSECTION OF THE ABDOMEN AND ITS CONTENTS.

Plate XXI